

# EQUIVOCAL ENFORCEMENT: REGULATORY DISPUTES IN OSHA

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**Abstract.** Research on the effectiveness of government regulatory enforcement has for the most part neglected the possibility of firms disputing agency charges. However, the Administrative Procedure Act (APA) of 1946 requires U.S. federal agencies to have an internal appeals system, which provides an initial forum for such disputes. Moreover, regulatory disputes are not unusual: 67 percent of citation items issued by Occupational Safety and Health Administration (OSHA) in 1990-2000 were disputed. This paper addresses following questions – Which circumstances in the enforcement-compliance scenario result in a dispute? What determines firms’ success in negotiating the “punishment”?

Theoretical analysis of regulatory disputes is carried out using a sequential bargaining game between the regulator and the firm. The players are uncertain about true compliance status and update their estimates with information that arrives gradually over the course of negotiations. The analysis indicates that the firm is more likely to negotiate if the variance of the regulator’s estimate is high, the rates of new information arrival are high, and this information is not too “noisy”. The firms that go further along in the appeals process get more substantial reductions in “punishment” due to selectivity bias.

Empirical analysis of regulatory disputes is performed using OSHA violations at pulp and paper, oil, and steel industry establishments in 1990-2000. Results suggest that citations produced by more thorough inspections are less likely to be disputed. Larger and more profitable firms have an advantage in negotiating with OSHA due to economies of scale in legal expenditures. Success of an appeal is primarily determined by the initial properties of the citation – more serious proposed “punishment” results in more substantial reductions of the same.

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## 1. Introduction

Most studies in the area of regulatory economics maintain the assumption that detection of an offence amounts to conviction. However, enforcement of regulations is equivocal for a variety of reasons. Perfect monitoring is not cost effective, and, in most cases, impossible. In addition, regulations are often subject to varying interpretations. In this uncertain environment, disputes over validity of the agency charges will inevitably arise. The Administrative Procedure Act (APA) of 1946 requires the U.S. federal agencies to have an internal appeals system, which provides an initial forum for such disputes. Thus, not only do the agency and the firms balance the costs and the benefits of compliance and enforcement, but also those of the appeals process. This paper takes a closer look at the causes and outcomes of the regulatory disputes in the context of regulations that are designed to improve health and safety at workplaces under the OSH Act.

Regulatory disputes are not unusual. In fact, only 43 percent of citation items issued by Occupational Safety and Health Administration (OSHA) in 1990-2000 were not disputed. In 44 percent of cases OSHA and firms were able to reach an informal settlement agreement, but nearly 12 percent of citation items were contested before an independent administrative body, the Occupational Health and Safety Review Commission (OSHRC). Moreover, approximately 5 percent of proposed citation items were deleted and only 60 percent of initial penalties were sustained. Major regulatory dispute cases are also often mentioned in the business press (see examples in Garber (1996), Harbour (1995), and Hench (1997)).

Phenomenon of the administrative appeals first enters the academic literature in papers that relax the assumptions of the basic law enforcement model described in seminal works by Becker (1968) and Stigler (1970) by considering the implications of the fact that enforcement actions may be subject to challenge *ex post*. These include Kambhu (1989; 1990), Kadambe and Segerson (1998), Nowell and Shogren (1994), Kim (1993), and Jost (1997a; 1997b). The central conclusion is that compliance outcomes and expected welfare would worsen if the firms were provided with an option to contest (see Kambhu (1989, 1990), Kadambe and Segerson (1998), Nowell and Shogren (1994), Kim (1993)). Therefore, the natural policy implication is that the institutions of enforcement need to restrict the channels, through which the decisions of the regulator can be challenged.

However, regulatory economics literature to date did not address a series of interesting issues pertaining to the regulatory disputes directly. For instance, which circumstances in the enforcement-compliance scenario result in a dispute? As mentioned before, 44 percent of citations proposed by OSHA are not negotiated. What makes the agency and the regulatee settle the dispute versus bringing it to trial before the third party? What determines the firm's success in negotiating the "punishment"?

This paper attempts to address this questions both, theoretically and empirically. First, modeling approaches from the literature on dispute resolution, which concentrates on the analysis of bargaining situations in a variety of substantive bodies of law (see Cooter and Rubinfeld (1989), Kessler and Rubinfeld (2004)), are adopted to create a sequential bargaining game with two players – the regulator and the firm. True compliance status of the firm is uncertain to both parties and can only be revealed during the third party hearing. Based on results of inspection, the regulator proposes a "punishment" that he considers appropriate given the allegations. Firm forms its own estimate. Additional information about the true underlying compliance status arrives gradually over the course of negotiations. The players use that to update their respective estimates.

Some of the interesting conclusions are as follows. The firm is more likely to engage in negotiations if the regulator is not too sure about his estimate of an appropriate "punishment", i.e. the variance of the regulator's prior is big. The firm will file a Notice of Contest (versus

trying to argue informally) if formal to informal negotiations cost ratio is relatively low, but the information arrival rate is higher in the formal phase. The length of negotiations depends on the information arrival rates and quality of that information. If there is no learning potential then the case either would not be disputed at all, or it would go to trial as soon as possible. However, if the rate of information arrival is high and the information is precise, then the player's beliefs about the true compliance status will be brought closer to the truth and each other sooner, which would result in a higher likelihood of settlement.

The empirical analysis of regulatory disputes in OSHA in this paper concentrates on the players' choices of negotiation tactics (whether to appeal, settle, and how far to follow the appeals process) and their outcomes in terms of violation type changes, penalty reductions and extensions of the abatement deadlines. Health and safety violation histories were collected for set of pulp and paper mills, oil refineries, and steel mills located in the federal OSHA jurisdiction. The time span for the analysis is 1990-2000. A reduced-form negotiation behavior model was estimated using Multinomial Probit to allow for correlation of the expected payoffs associated with different strategy options. Negotiation outcome models were corrected for selectivity bias using predicted probabilities from the first stage negotiation behavior model.

Results suggest that negotiation behavior is affected by initial properties of the citation; amount of information gathered by the inspector; firm size, profitability, and past enforcement-compliance history. More serious initial "punishment" results in higher probability of negotiations. More thorough inspections lead to "better quality" citations, which are harder for firms to negotiate. In such cases, firms are more likely to either avoid negotiations or got to trial directly. This finding offers support for the theoretical conclusion that lower variance of the regulator's initial appropriate "punishment" estimate makes the regulator less receptive to subsequently arriving (mitigating) information. Larger and more profitable firms and establishments seem to have an advantage in negotiating with OSHA due to economies of scale in legal expenditures. Negotiation outcomes, however, are primarily determined by the initial properties of the citation – more serious citation results in more substantial reductions.

This paper is organized as follows. Section 2 contains theoretical analysis of a regulatory dispute using sequential bargaining model. The empirical analysis of the regulatory disputes using OSHA data is in Section 3. Concluding remarks are in Section 4.

## 2. Game-Theoretic Analysis of Regulatory Disputes

The process of bargaining between the agency and the regulatees was not explicitly studied in the past literature. In this section it is analyzed theoretically using a perfect information sequential bargaining model with stochastic learning.

This modeling approach is borrowed from the literature on dispute resolution in a variety of substantive bodies of law: contracts, torts, and property (see Cooter and Rubinfeld (1989), Kessler and Rubinfeld (2004)). Scholars in this area are involved in extensive modeling and applied analysis of these bargaining situations, with an aim to explain conditions that make the plaintiff and the defendant settle, probability of the plaintiff to win a suit, and timing of settlement and timing of filing a suit.

A typical litigation model includes a plaintiff, who decides whether to file a claim. The extent of harm is usually known and it is a matter of court to decide whether this was due to the negligent behavior of the defendant. Some of the models (Spier (1992) and Sieg (2000)) incorporate asymmetric information assumption that the defendant knows the degree of own negligence with certainty. Negotiations are modeled as one-shot game, because the plaintiff and the defendant typically meet under these circumstances for the first time and are not expected to repeat the process after the game is over.

However, there are several important distinctions in modeling administrative appeals process. The defendant (the firm) assumes an active role in the process, i.e. the decision to

negotiate the punishment and, subsequently, to formally contest it are to be made by the firm. The truth about compliance status (and thus, the extent of the violation) is seldom known to either party. The regulator grounds his belief based in the inspection results, which are suggestive, but may not be complete, and his experience with this or other firms. The firm may be not well aware of its own compliance status too, since most violations are NOT classified as “willful”, i.e. involving prior knowledge about them by the firm. In addition, the regulator and the firm may have pre-existing history of negotiating punishments, and they may as well care about the reputation effects their current actions. In regulator’s case, the reputation effects may be specific (pertaining to the firm, with which he is currently negotiating) and general (pertaining to all other firms in his jurisdiction).

The present model formalizes all the features of the administrative appeals process with the exception of the reputation effects, which would require repeated a game approach. In its essence, the model is closest to those used by Watanabe (2004), Yildiz (2004), Spier (1992) and Sieg (2000) in the area of medical malpractice litigation.

The players in this bargaining game are the regulator ( $r$ ) and the firm ( $f$ ). Both players are risk neutral and have a common time discount factor  $\beta \in [0, 1]$ <sup>1</sup>. In the course of the game the players bargain over the appropriate punishment  $x$ ,  $x \geq 0$ .

Information about true compliance status of the firm  $v$ ,  $v \in R$ , is uncertain.  $v$  is a random variable, whose realization happens in the beginning of the game at time  $t = 0$ . True  $v$  does not evolve during the game and can only be determined at the hearing, when all evidence has been discovered. The punishment that is then chosen by the court is:

$$(1) \quad V = \begin{cases} 0, & v \leq 0 \\ v, & v > 0 \end{cases}$$

Operationally,  $V$  represents a combination of penalties and present value abatement costs required to eliminate the hazard.<sup>2</sup>  $V$  is assumed to be measured in the same units as  $v$ . Note that there are no rewards for “over-achievers” in terms of safety at the workplace –  $V$  is bound by zero from below. In reality, there is a cap on penalties too, but in this game it shall be ignored.

After inspection, at time  $t = 0$ , the firm and the regulator form their beliefs about  $v$ . Player’s  $i$ ,  $i \in \{f, r\}$ , belief system is a distribution, conditional upon facts uncovered during the inspection and other relevant information, known to the player  $i$ . It can be interpreted as player’s  $i$  prior.

There is no reason for the priors of the firm and the regulator to be same. The best point estimate of  $v$  by player  $i$  at time  $t = 0$  is the mean of the corresponding distribution,  $v_0^i$ . Denote the variance of this estimate by  $P_0^i$ . For simplicity, it is assumed that both players’ distributions are Normal (and thus are completely described by the two parameters above). As information about the case starts arriving during negotiations, these distributions undergo Bayesian updating to incorporate new facts.

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<sup>1</sup>One might argue that the rates, at which the regulator and the firm discount the future differ. For example, the regulator could be using a “social discount rate”, which is lower than the one used by the private sector and, thus, allows to carry out projects that have benefits occurring further in the future. However, it is unclear that this is applicable in the context of administrative appeals: the regulator might, in fact, have a higher discount rate because faster elimination of workplace hazards may be more beneficial for the society. It is fairly straightforward to incorporate differing discount rates, but this detail does not change the main implications of the model.

<sup>2</sup>Closer abatement date will result in higher present value of the abatement costs. Thus, closer abatement date also implies higher  $V$ .

## 2.1. Structure of the Game

The game begins at time  $t = 0$ , when the regulator issues a notice of violation to the firm if, according to the inspector's best guess, the firm has violated a regulation ( $v_0^r > 0$ ).<sup>3</sup> The notice of violation is equivalent to the regulator's request to obtain amount  $V_0^r$  from the firm. Of course, the firm does not actually pay the regulator – it spends a certain amount on abatement, while the penalties, in case of OSHA, are turned over to the Secretary of Labor for deposit into the Treasury of the United States. However, for modeling purposes, it is assumed here that the penalties and the present value of the abatement costs are paid to the regulator, who then also uses the abatement funds to eliminate hazards<sup>4</sup>.

$V_0^r$  is formed as the regulator's best guess at what the appropriate punishment should be, given his belief at that point of time. As the punishment can only take on non-negative values, the distribution for the punishment values coincides with that for the compliance status for the positive range, but is censored at 0.  $V_0^r$  is the mean of this censored distribution:

$$(2) \quad V_0^r = \Phi\left(\frac{v_0^r}{\sqrt{P_0^r}}\right) \left( v_0^r + \sqrt{P_0^r} \lambda\left(\frac{v_0^r}{\sqrt{P_0^r}}\right) \right)$$

Where  $\Phi(v_0^r/\sqrt{P_0^r})$  is cumulative standard normal distribution,  $\phi(v_0^r/\sqrt{P_0^r})$  is standard normal density, and  $\lambda = \phi(v_0^r/\sqrt{P_0^r})/\Phi(v_0^r/\sqrt{P_0^r})$  is the inverse Mills ratio. Whether  $V_0^r$  is greater than  $v_0^r$  depends on  $v_0^r/P_0^r$  and  $\lambda_0^r$ , but  $V_0^r > v_0^r$  if  $v_0^r < 0$ .

Similarly, the firm forms its own estimate of an appropriate punishment  $V_0^f$ , based on its beliefs  $N(v_0^f, P_0^f)$ . Note that, although  $v_0^r > 0$ , the firm can still be under impression that it is not guilty of allegations, i.e.  $v_0^f \leq 0$ .

At time  $t = 0$ , given commonly known beliefs about the just punishment  $V_0^f$  and  $V_0^r$ , the firm may choose to pay  $V_0^r$  or start negotiations. If the latter happens, the informal negotiations phase (*I*) begins at time  $t = 1$ . Depending on whether the firm subsequently files the notice of contest, the game may shift to the formal negotiations phase (*F*). Figure (1) presents the structure of the game diagrammatically.

Phase *I* consists of multiple periods. In each of these periods players bargain and can, potentially, reach an agreement or the firm can quit the negotiations (by abating hazards and paying current penalties), which would finish the game. Phase *I* lasts  $T_I < \infty$  periods.<sup>5</sup> If neither settlement was reached nor the notice of contest was filed nor the firm quit, at time  $1 + T_I + 1$  the firm has to abate all the hazards and pay the penalties (and, thus, the game is over).

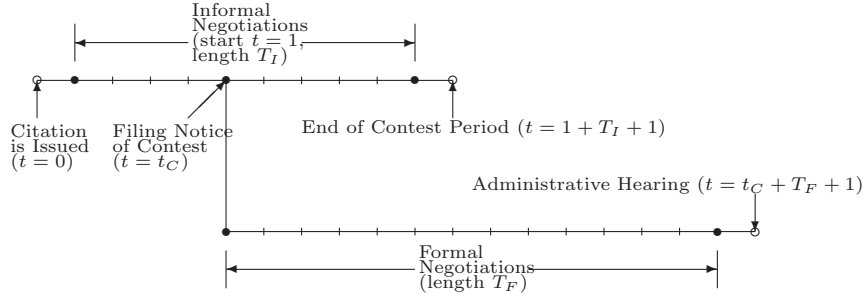
If the firm files the notice of contest, the game moves to the pre-trial phase *F*. The date of contest  $t_C \in \{1, 2, \dots, T_I\}$  is determined endogenously. The length of the formal negotiations phase is finite  $T_F < \infty$ , as fixed hearing date becomes known to both the players at  $t_C$ . The players bargain in each of the periods of the phase *F* and can reach out-of-court settlement prior to the hearing date. If they fail to do so, the case is resolved by judgement at  $t_C + T_F + 1$ .

Starting with period  $t = 1$ , both players incur per-period legal costs  $C_i^J \in R^+$ , where  $i \in \{r, f\}$  and  $J \in \{I, F\}$ . Costs of the players are allowed to differ ( $C_r^J \neq C_f^J, \forall J$ ). The usual assumption of the litigation models that costs in the informal phase are lower than in the pre-trial phase is deemed appropriate also in case of administrative appeals. Typically, in the

<sup>3</sup>The implicit assumption here is that the regulator is not malicious, i.e. he pursues the cases, when he believes that violation has happened.

<sup>4</sup>This is needed to make sure that the regulator and the firm are arguing over the same amount. Also, it allows to avoid abatement verification issues

<sup>5</sup>The firm has a limited contest period – 15 days after the Notice of Violation was issued



After the citation is issued at time  $t = 0$ , the firm can either accept the penalty (and, thus, game is over) or begin informal negotiations phase with at  $t = 1$ . Each stage of the informal phase can result in the firm and the regulator achieving an informal settlement or the firm filing the notice of contest or firm quitting negotiations (by abating hazards and paying current penalties). If neither event happened, the contest period ends at  $1 + T_I + 1$  and the firm is obliged to abate the hazard as well as pay penalties specified in the notice of violation. When the notice of contest is filed at  $t_C$ , the negotiations move to the formal phase. The administrative hearing date  $t_C + T_F + 1$  becomes known to both the parties. In each period prior to that, the firm and the regulator can achieve formal settlement.

Figure 1. Structure of the Model

informal phase the firm represents itself, while negotiating with OSHA Area Director. Once the Notice of Contest is filed, OSHA is represented by attorneys. Firms are generally advised, but not required, to get legal consultation and/or representation. Thus, it is assumed here that  $C_i^I < C_i^F$ ,  $\forall i$ .

## 2.2. Arrival of Information and Learning

Phases  $I$  and  $F$  consist of multiple periods ( $t \in \{1, 2, \dots, T_I\}$  and  $t \in \{t_C, \dots, T_F\}$ , respectively), when players play the same bargaining game, conditional on the information set at time  $t$ .<sup>6</sup> Information relevant to the case is observed in the beginning of the each period with probability  $\theta_J$ ,  $J \in \{I, F\}$ .

This information can be, for instance, mitigating circumstances, which were not discovered during the inspection, test results, expert and employee testimonies. The rate at which such information is observed, is higher in the pre-trial negotiations phase  $F$  ( $\theta_F > \theta_I$ ), due to mandatory discovery procedures associated with administrative trial.

As this is a perfect information game, the information and the rates of its observation are common knowledge. Therefore, strategic uses of the information, like non-disclosure of the unfavorable evidence, which imply informational asymmetry, are not possible in this setup<sup>7</sup>.

The player who gets to present this information has the right to propose a settlement at the amount  $x$ . The regulator becomes the proposer with probability  $\rho$ , while the firm – with probability  $1 - \rho$  ( $\rho$  is as well commonly observed). The other player may accept or decline the settlement. If the settlement is accepted, the game concludes with the firm paying  $x$  to the regulator.

<sup>6</sup>The setup is adopted from Watanabe (2004). Yildiz (2004) provides similar learning model with deterministic arrival of the information.

<sup>7</sup>Given that the truth can be determined during the hearing, a non-disclosure option would most likely result in higher settlement rates. However, this question requires further investigation.

In the phase  $I$ , if the proposal is rejected and firm is willing to negotiate further, the firm decides whether to contest. If the case is not contested, the same game is played in the next period, up until the contest phase is over. In the end of the contest period, the firm pays a (possibly) amended amount declared by the regulator ( $V_{1+T_I+1}^r$ ).

If the case is contested, the game moves to the phase  $F$ . The period-games are played in an analogous manner, with information arriving at a higher rate. If the players settle then the dispute is resolved out-of-court. If not – the dispute is resolved by judgement, with the firm paying  $V$ .

As mentioned before, neither the regulator nor the firm know true  $V$ . Also, they have different priors that generate their best estimates of  $V$ , which are common knowledge.

In this model, Kalman (1960) filtering approach is applied to formalize the mechanism of updating the distribution parameters based on new information (i.e. the learning process). Kalman filter is used to find a series of unbiased estimates of the unknown state variable using the newly arriving information about the state variable (measured with error). In this case, the state variable  $v$  does not actually evolve ( $v_t = v_{t-1}$ ) and there is no randomness associated with it over the course of the game.

In the beginning of each period  $t$ , information is observed with probability  $\theta_J$ ,  $J \in \{I, F\}$ . Denote the indicator function  $\{\delta_t\}$  to be 1 if information gets revealed and 0 otherwise. Whether observed or not, the law governing arrival of new information  $k_t$  is as follows:

$$(3) \quad k_t = v + \eta_t$$

The process  $\eta_t$  is White Noise ( $E(\eta_t) = 0$  and  $E(\eta_t^2) = \sigma^2$ ). What is actually observed by the players can be then denoted as:

$$(4) \quad d_t = \{\delta_t\}(v + \eta_t) = \begin{cases} v + \eta_t, & \text{with probability } \theta_J \\ 0, & \text{with probability } 1 - \theta_J \end{cases}$$

Beliefs are getting updated only when information arrives. Using the mechanics of Kalman Equations (see Pollock (1999) p. 244), the updating process is described by expressions below:

$$(5) \quad \begin{aligned} v_t^i &= \begin{cases} v_{t-1}^i + K_t^i (k_t - v_{t-1}^i), & \text{with probability } \theta_J \\ v_{t-1}^i, & \text{with probability } 1 - \theta_J \end{cases} \\ P_t^i &= \begin{cases} P_{t-1}^i - \frac{(K_t^i)^2}{P_{t-1}^i + \sigma^2}, & \text{with probability } \theta_J \\ P_{t-1}^i, & \text{with probability } 1 - \theta_J \end{cases} \end{aligned}$$

The expression  $K_t^i = P_{t-1}^i / (P_{t-1}^i + \sigma^2)$  is called Kalman gain, while  $k_t - v_{t-1}^i$  is a prediction error. Note that the updated estimate of variance declines, as knowledge increases ( $P_t^i < P_{t-1}^i$ ). This implies that the impact of new information on the players' best guesses declines over time, as more of it arrives. Kalman gain decreases in variance of the estimate, and, therefore, there is smaller adjustment made per unit of the prediction error.

Finally, let the series  $D_t = \{d_1, d_2, \dots, d_t\}$  denote the information state at time  $t$ .

### 2.3. The Equilibrium Concept

This model is a perfect information dynamic game. Therefore, subgame-perfect equilibrium is an appropriate equilibrium concept. Given that the game has finite horizon, backward induction can be utilized as a solution method – the analysis begins in the last period of the pre-trial negotiations phase  $F$  and then moves backward, to time  $t = 0$ , when the firm makes its “whether-to-negotiate” decision.

## 2.4. Phase F: Formal Negotiations

The subgames in the phase  $F$  are reached only if the firm decided to negotiate the punishment at time  $t = 0$  and, subsequently, moved to contest the regulator's decision in some period  $t$  of the informal negotiations phase  $I$ ,  $t \in \{1, 2, \dots, 1 + T_I\}$ . Consider the last period-game of the phase  $F$ , which happens at  $t = t_C + T_F + 1$ . The players did not manage to settle in any of the periods prior to this date. Therefore, the case is resolved by judgement.

Denote the phase  $F$  payoff of the player  $i$  at  $s$ th period since the beginning of the phase (i.e.,  $s = t - t_C$ ) by  $\mathbb{F}_s^i$ . At time  $s = T_F + 1$ , judgement reveals the true  $V$ , thus, the state of knowledge from the beginning of negotiations becomes  $D_{t_C+T_F+1} = \{d_1, d_2, \dots, d_{t_C+T_F}, V\}$ . The payoffs can then be written as:

$$(6) \quad \mathbb{F}_{T_F+1}^r(D_{t_C+T_F+1}) = -\mathbb{F}_{T_F+1}^f(D_{t_C+T_F+1}) = V$$

Now, consider the period before last,  $s = T_F$ . The state of knowledge at this time does not include  $V$ , i.e.  $D_{t_C+T_F} = \{d_1, d_2, \dots, d_{t_C+T_F}\}$ . Define player's  $i$  continuation value as the payoff he expects to get in the next stage of the game. The respective continuation values can be then expressed as:

$$(7) \quad \begin{aligned} \mathbf{F}_{T_F}^r(D_{t_C+T_F}) &= \beta E_{t_C+T_F}^r[\mathbb{F}_{T_F+1}^r(D_{t_C+T_F+1})] \\ \mathbf{F}_{T_F}^f(D_{t_C+T_F}) &= \beta E_{t_C+T_F}^f[\mathbb{F}_{T_F+1}^f(D_{t_C+T_F+1})] \end{aligned}$$

Therefore, the settlement amount  $x$  which the regulator would be willing to accept at time  $t_C + T_F$  should be greater than his continuation value:

$$(8) \quad x_{t_C+T_F} \geq \beta E_{t_C+T_F}^r[\mathbb{F}_{T_F+1}^r(D_{t_C+T_F+1})]$$

Similarly, the firm would not be willing to pay a settlement  $x$  that exceeds its continuation value:

$$(9) \quad x_{t_C+T_F} \leq -\beta E_{t_C+T_F}^f[\mathbb{F}_{T_F+1}^f(D_{t_C+T_F+1})]$$

Adding up equations (9) and (8) we obtain the condition for settlement in the last period before judgement  $t_C + T_F$ .

$$(10) \quad E_{t_C+T_F}^r[\mathbb{F}_{T_F+1}^r(D_{t_C+T_F+1})] + E_{t_C+T_F}^f[\mathbb{F}_{T_F+1}^f(D_{t_C+T_F+1})] \leq 0$$

Now let's consider any subgame  $s$  of the phase  $F$ , which happens prior to time  $t_C + T_F$ . The conditions for the players to accept a settlement  $x_t$  are similar to (8) and (9), but they have to include legal costs incurred in the next period-game:

$$(11) \quad x_t \geq \beta E_t^r[\mathbb{F}_{t-t_C+1}^r(D_{t+1}) - C_F^r]$$

$$(12) \quad x_t \leq \beta E_t^f[-\mathbb{F}_{t-t_C+1}^f(D_{t+1}) + C_F^f]$$

Thus, the condition for settlement at time  $t$  if the phase  $F$  was reached becomes:

$$(13) \quad E_t^r[\mathbb{F}_{t-t_C+1}^r(D_{t+1})] + E_t^f[\mathbb{F}_{t-t_C+1}^f(D_{t+1})] \leq C_F^r + C_F^f$$

This is a classic result in the litigation literature – for the settlement to happen, the sum of the gains, expected in the future, should be less than the sum of the costs incurred in the

process of getting them. However, the expression (13) is not informative about the actual settlement amount  $x_t$ .

If the regulator is the proposer of the settlement (which happens with probability  $\rho$ ), then he would set the settlement amount to the maximum value the firm is willing to pay, i.e. its continuation value:

$$(14) \quad x_t = -\mathbf{F}_{t-t_C}^f(D_t) = \beta E_t^f[-\mathbb{F}_{t-t_C+1}^f(D_{t+1}) + C_F^f]$$

The firm will be bound to accept. Settling at the amount in (14) is acceptable to the regulator as well because  $-\mathbf{F}_{t-t_C}^f(D_t) \geq \mathbf{F}_{t-t_C}^r(D_t)$  (see (12)).

If the firm is the proposing party (with probability  $1 - \rho$ ), then it would offer the minimum amount that the regulator is willing to accept, i.e. his continuation value:

$$(15) \quad x_t = \mathbf{F}_{t-t_C}^r(D_t) = \beta E_t^r[\mathbb{F}_{t-t_C+1}^r(D_{t+1}) - C_F^r]$$

Thus, the expected payoffs at time  $t$  if the game is already in phase  $F$  can be described as follows:

$$(16) \quad \mathbb{F}_{t-t_C}^r(D_t) = \begin{cases} \rho \beta E_t^f[-\mathbb{F}_{t-t_C+1}^f(D_{t+1}) + C_F^f] + (1 - \rho) \beta E_t^r[\mathbb{F}_{t-t_C+1}^r(D_{t+1}) - C_F^r], & \text{if (13) true} \\ \beta E_t^r[\mathbb{F}_{t-t_C+1}^r(D_{t+1}) - C_F^r], & \text{otherwise} \end{cases}$$

$$(17) \quad \mathbb{F}_{t-t_C}^f(D_t) = \begin{cases} \rho \beta E_t^f[\mathbb{F}_{t-t_C+1}^f(D_{t+1}) - C_F^f] + (1 - \rho) \beta E_t^r[-\mathbb{F}_{t-t_C+1}^r(D_{t+1}) + C_F^r], & \text{if (13) true} \\ \beta E_t^f[\mathbb{F}_{t-t_C+1}^f(D_{t+1}) - C_F^f], & \text{otherwise} \end{cases}$$

The description of the equilibrium in the subgame  $t$  of the phase  $F$  is accomplished. The summary of the findings is re-stated in proposition (2.1).

**Proposition 2.1.** *In any period  $t$  of the phase  $F$ , the unique subgame perfect equilibrium is characterized by the payoffs described in (16) and (17). The settlement occurs if (13) holds. Given that players settle at time  $t$ , the amount of settlement  $x_t$  is described by (14) if the regulator is the proposer and by (15) if the firm is the proposer.*

## 2.5. Phase I: Informal Negotiations

As in case of the phase  $F$ , the analysis of the equilibrium conditions begins in the last stage of the phase  $I$ . If the players did not leave the game before  $1 + T_I + 1$  (by settling or by the firm filing the notice of contest or quitting the game), the firm has to pay a (possibly) amended penalty, which regulator comes up with in the beginning of  $1 + T_I + 1$ . Thus, the payoffs of the players at this stage are:

$$(18) \quad \mathbb{I}_{1+T_I+1}^r(D_{1+T_I+1}) = -\mathbb{I}_{1+T_I+1}^f(D_{1+T_I+1}) = V_{1+T_I+1}^r$$

At the stage prior to the last,  $t = 1 + T_I$ , the firm has several options. It can quit the game by paying the current penalty set by the regulator (the payoff  $-V_{1+T_I}^r$ ), or move to the last stage of the game, which is associated with continuation value  $\beta E_{1+T_I}^f[-V_{1+T_I+1}^r(D_{1+T_I+1})]$ , or file the notice of contest and shift the game to the phase  $F$  with continuation value  $\beta E_{1+T_I}^f[\mathbb{F}_1^f(D_{1+T_I+1}) - C_F^f]$ . Thus, depending on which these options has bigger payoff, the continuation value for the firm at  $1 + T_I$  can be written as:

$$(19) \quad \mathbf{I}_{1+T_I}^f(D_{1+T_I}) = \max \left\{ -V_{1+T_I}^r, \beta E_{1+T_I}^f[-V_{1+T_I+1}^r(D_{1+T_I+1})], \beta E_{1+T_I}^f[\mathbb{F}_1^f(D_{1+T_I+1}) - C_F^f] \right\}$$

Associated regulator's continuation values at time  $1 + T_I$  are:

$$(20) \quad \mathbf{I}_{1+T_I}^r(D_{1+T_I}) = \begin{cases} V_{1+T_I}^r \\ \beta E_{1+T_I}^r[V_{1+T_I+1}^r(D_{1+T_I+1})] \\ \beta E_{1+T_I}^r[\mathbb{F}_1^r(D_{1+T_I+1}) - C_F^r] \end{cases}$$

Similarly, at time  $1 + T_I$  the firm will accept settlements  $x_{1+T_I}$ , which do not exceed its continuation value. The regulator will not accept anything below his continuation value.

$$(21) \quad x_{1+T_I} \leq -\mathbf{I}_{1+T_I}^f(D_{1+T_I})$$

$$(22) \quad x_{1+T_I} \geq \mathbf{I}_{1+T_I}^r(D_{1+T_I})$$

Therefore, the settlement condition for the period  $1 + T_I$  is:

$$(23) \quad \mathbf{I}_{1+T_I}^r(D_{1+T_I}) + \mathbf{I}_{1+T_I}^f(D_{1+T_I}) \leq 0$$

Note that if it is optimal for the firm to quit the game at  $1 + T_I$ , i.e.  $\mathbf{I}_{1+T_I}^f(D_{1+T_I}) = -V_{1+T_I}^r$ , then it is equivalent to saying that the firm and the regulator would settle at this amount. However, if the firm decides to wait until last period information before accepting the penalty (which is costless, as there are no legal fees in the last period and the penalty payment is deferred to the future), i.e.  $\mathbf{I}_{1+T_I}^f(D_{1+T_I}) = \beta E_{1+T_I}^f[-V_{1+T_I+1}^r(D_{1+T_I+1})]$ , the settlement is not guaranteed because firm's expectation of that amount may be significantly different from that of the regulator ( $\mathbf{I}_{1+T_I}^r(D_{1+T_I}) = \beta E_{1+T_I}^r[V_{1+T_I+1}^r(D_{1+T_I+1})]$ ). In other words, if the formal contest seems unprofitable, the firm might still wait if it expects better luck in the final period (i.e. is relatively optimistic). This result stresses the importance of learning in the present model.

Now let us generalize the result for any period other  $t = \{1, 2, \dots, 1 + T_I - 1\}$  of the informal phase  $I$ . The respective continuation values for the players would have to include costs of informal negotiations in the next period, unlike before:

$$(24) \quad \mathbf{I}_t^f(D_t) = \max \left\{ -V_t^r, \beta E_t^f[\mathbb{I}_{t+1}^f(D_{t+1}) - C_I^f], \beta E_t^f[\mathbb{F}_1^f(D_{t+1}) - C_F^f] \right\}$$

$$(25) \quad \mathbf{I}_t^r(D_t) = \begin{cases} V_t^r \\ \beta E_t^r[\mathbb{I}_{t+1}^r(D_{t+1}) - C_I^r] \\ \beta E_t^r[\mathbb{F}_1^r(D_{t+1}) - C_F^r] \end{cases}$$

The condition for settlement at time  $t$  becomes:

$$(26) \quad \mathbf{I}_t^r(D_t) + \mathbf{I}_t^f(D_t) \leq 0$$

The payoffs of the players at time  $t$  are derived using the logic similar to one used for the pre-trial phase  $F$  solution. If the players do not settle, they get their continuation values as payoffs. However, if they do settle, then the identity of the proposer becomes important. If the regulator is the proposer, then the settlement amount is set at the continuation value of the firm, i.e.  $x_t = -\mathbf{I}_t^f(D_t)$ . If the firm is the proposer, then the settlement amount is the regulator's continuation value  $x_t = \mathbf{I}_t^r(D_t)$ . Thus, the payoffs can be then summarized by:

$$(27) \quad \mathbb{I}_t^r(D_t) = \begin{cases} -\rho \mathbf{I}_t^f(D_t) + (1 - \rho) \mathbf{I}_t^r(D_t), & \text{if (26) true} \\ \mathbf{I}_t^r(D_t), & \text{otherwise} \end{cases}$$

$$(28) \quad \mathbb{I}_t^f(D_t) = \begin{cases} \rho \mathbf{I}_t^f(D_t) + -(1 - \rho) \mathbf{I}_t^r(D_t), & \text{if (26) true} \\ \mathbf{I}_t^f(D_t), & \text{otherwise} \end{cases}$$

The findings that describe equilibrium in the subgame  $t$  of the phase  $I$  are summarized in proposition (2.2).

**Proposition 2.2.** *In any period  $t$  of the phase  $I$ , the unique subgame perfect equilibrium is characterized by the payoffs described in (27) and (28). The settlement occurs if (26) holds. Given that players settle at time  $t$ , the amount of settlement  $x_t$  is described by (24) if the regulator is the proposer and by (25) if the firm the proposer.*

*The firm decides to quit the negotiations iff*

$$-V_t^r > \beta E_t^f[\mathbb{I}_{t+1}^f(D_{t+1}) - C_I^f] \text{ and } -V_t^r > \beta E_t^f[\mathbb{F}_1^f(D_{t+1}) - C_F^f].$$

*The firm decides to contest the case iff*

$$\beta E_t^f[\mathbb{F}_1^f(D_{t+1}) - C_F^f] > \beta E_t^f[\mathbb{I}_{t+1}^f(D_{t+1}) - C_I^f] \text{ and } \beta E_t^f[\mathbb{F}_1^f(D_{t+1}) - C_F^f] > -V_t^r.$$

Characterization of the subgame perfect equilibrium in the phase of informal negotiations  $I$  includes two important tradeoffs. First, the firm decides to quit negotiations because the impact of information declines over time, while cost of learning new information is constant, and/or the expectations become pessimistic (i.e. future settlement and/or winning the case in court is unlikely because the regulator's case is too strong). The second tradeoff is about firm's decision to contest. The firm will contest if it thinks that current penalties are unacceptable, there is little new information to be derived from the informal negotiations and the costs of formal negotiations are relatively low in comparison to potential favorable information flow (i.e. expected reduction in penalty). The firm ought to be fairly optimistic about the outcome as well.

## 2.6. Decision to Engage in Negotiations

Finally, consider firm's decision to bargain with the regulator at time  $t = 0$ . If the firm does not negotiate, it will have to pay  $V_0^r$  and the case is closed. However, if it does, then it can expect to pay  $\beta E_0^f[\max\{\mathbb{I}_1^f(D_1) - C_I^f, \mathbb{F}_1^f(D_1) - C_F^f\}]$ . Thus, the firm will engage in negotiations iff:

$$(29) \quad -V_0^r < \beta E_0^f[\max\{\mathbb{I}_1^f(D_1) - C_I^f, \mathbb{F}_1^f(D_1) - C_F^f\}]$$

Which is to say that firm is fairly optimistic about informal or formal (in case it immediately files the notice of contest) negotiations. The loss that it expects to incur in the future, which is the sum of the adjusted penalty and costs of negotiations, is less than the loss it would incur by paying current penalty without attempting to bargain.

It is instructive to see why such optimism may arise. As it has been demonstrated before, both  $E_0^f[\mathbb{I}_1^f(D_1)]$  and  $E_0^f[\mathbb{F}_1^f(D_1)]$  depend on firm's expectations of  $V_1^f$  and  $V_1^r$ . If the firm is expecting  $V_1^r$  to be substantially smaller than current  $V_0^r$ , then might be beneficial to start negotiations or file the notice of contest even if it is costly.

These expectations depend on arrival of (mitigating) information  $k_1$ , which would lead to updates of the firm's and the regulator's priors. Based on firm's beliefs at time  $t = 0$ , the best guess of the value of  $k_1$  (see equation (3)), if it arrives, is then firm's current best estimate of  $v$ , i.e.  $E_0^f[k_1] = v_0^f$ .

Therefore, according to equations (5), firm generates expected parameter values of its own and the regulator's distributions:

$$(30) \quad \begin{aligned} E_0^f[v_1^f] &= v_0^f \\ E_0^f[P_1^f] &= P_0^f - \theta_J \frac{(K_0^f)^2}{P_0^f + \sigma^2} \end{aligned}$$

$$(31) \quad \begin{aligned} E_0^f[v_1^r] &= v_0^r + \theta_J K_0^r (v_0^f - v_0^r) \\ E_0^f[P_1^r] &= P_0^r - \theta_J \frac{(K_0^r)^2}{P_0^r + \sigma^2} \end{aligned}$$

The expression (2), which is used to estimate appropriate punishment (as a mean of a corresponding censored distributions) is non-linear in  $v_t^i$  and  $P_t^i$ . To see how the expected updates affect firm's expectation of  $V_1^r$  and  $V_1^f$ , first order Taylor approximation of (2) around the vector of initial values  $(v_0^i, P_0^i)'$  is used:

$$(32) \quad \hat{V}(v_t^i, P_t^i) = \Phi \left( \frac{v_0^i}{\sqrt{P_0^i}} \right) v_t^i + \phi \left( \frac{v_0^i}{\sqrt{P_0^i}} \right) \frac{P_t^i + P_0^i}{2\sqrt{P_0^i}}$$

Using (30)-(32), firm's expectations of  $V_1^r$  and  $V_1^f$  at time  $t = 0$  can be written as:

$$(33) \quad E_0^f[V_1^f] \approx V_0^f - \theta_J K_0^f \frac{K_0^f}{P_0^f + \sigma^2} \frac{\phi \left( v_0^f / \sqrt{P_0^f} \right)}{2\sqrt{P_0^f}}$$

$$(34) \quad E_0^f[V_1^r] \approx V_0^r + \theta_J K_0^r \left[ \Phi \left( v_0^r / \sqrt{P_0^r} \right) (v_0^f - v_0^r) - \frac{K_0^r}{P_0^r + \sigma^2} \frac{\phi \left( v_0^r / \sqrt{P_0^r} \right)}{2\sqrt{P_0^r}} \right]$$

Note that both expectations have a negative component, which comes from the fact that new information decreases variance of the true compliance status estimates  $v_1^f$  and  $v_1^r$ . Due to the fact that  $V_1^f$  and  $V_1^r$  are means of the censored distributions, decline in the non-censored variance decreases the these means.

Now, if at time  $t = 0$  firm's assessment of own guilt  $v_0^f$  is smaller than that of the regulator,  $v_0^r$ , then the expression (34) gets another negative component due to  $v_0^f - v_0^r$ . This results in the firm expecting that the regulator will adjust  $V_1^r$  down in the future. The magnitude of adjustment depends, among other things, on the Kalman gain,  $K_0^i$ , which increases in variance of the regulator's distribution  $P_0^r$  and decreases in the measurement error of the arriving information  $\sigma^2$ . Thus, if the regulator's estimate of  $v$  is imprecise or the information that is expected to arrive is not-noisy, then in firm's opinion it is more likely that the regulator would adjust the punishment down (if such high penalty is a mistake – the correction would be made).

Finally, the rate of information arrival  $\theta_J$ ,  $J \in \{I, F\}$ , is also important. In the extreme case of it being zero (i.e. no information about true  $v$  arrives up until the hearing day), the players cannot update their expectations. In such case, the case is either settled immediately by firm paying the penalty at time  $t = 0$  or the case is contested immediately and the players wait for the judgement.<sup>8</sup>

If the rates of information arrival are sufficiently low, the firm might not be as optimistic about negotiations as it would have been otherwise. Therefore, the decision to negotiate is

<sup>8</sup>See Watanabe (2004) for the proof of this finding in a similar model of medical malpractice litigation.

crucially dependent on whether there is a possibility to exchange information before the hearing (if any) and, thus, reach out-of-court settlement. The firm still might file a notice of contest, if it believes belief that appropriate  $V$  is low enough to compensate for stage  $F$  costs (and the variance of that estimate is small).

## 2.7. Main Implications

The framework chosen to represent the administrative appeals process is a sequential bargaining game with two players: the regulator and the firm. The game involves several stochastic elements. True compliance status of the firm is uncertain and may be revealed only by the third-party hearing. Information relevant to determination of the true compliance status may arrive during negotiations and is noisy. Some of the key assumptions are that formal negotiations are more costly for both the regulator and the firm (although nothing is known about relative cost magnitudes) and that probability of discovering useful information about the true compliance status is higher during formal negotiations.

There are several important exogenous variables and parameters that determine dynamics of the game: initial estimates of the true compliance status by the regulator and the firm; and the respective variances of these estimates. Under condition of Normality, for either player the point estimate of the compliance status and the variance of this estimate form the prior distribution for the unobserved true compliance status. These priors may depend on individual as well as joint past histories of the players. Important feature of these variables is that they undergo Bayesian updating over the course of the game as new information arrives. Other exogenous elements include costs of negotiations and rates of information arrival at different phases of the game, quality of arriving information, settlement proposer identity.

Equilibrium conditions for the model are outlined in the propositions (2.2) and (2.1). The key decisions examined are whether to engage in negotiations, or whether to file a Notice of Contest, or whether to settle in either phase. Several implications are drawn for the outcome of negotiations in terms of “punishment” reductions. The main findings and intuition behind them are provided below.

The firm is more likely to engage in negotiations if the “punishment” initially proposed by the regulator is more serious than firm’s own estimate and costs of doing so are relatively low. Information about the true underlying compliance status that can potentially be revealed during negotiations is an important element in firm’s decision to dispute. If the rate of information arrival is high and it is not too “noisy” then the firm would find it worthwhile to negotiate with the regulator.

In addition, the variance of the regulator’s estimate – that is the possibility of the regulatory error – also factors into the firm’s decision to negotiate. If this variance is high then anticipated favorable evidence would have bigger impact on the regulator’s updated estimate of the “punishment”. In other words, when the regulator is not too sure about the due “punishment”, he would be relatively easier to convince and, thus, negotiations may be fruitful.

The firm would file a formal Notice of Contest, instead of trying to argue informally, if formal to informal negotiation cost ratio is relatively low, but the information arrival rate is higher in the formal phase. That is, it is relatively cheaper to prove affirmative defenses in a formal contest before the third party than to persuade the regulator informally.

Settlements are more likely in any given period of the game if the sum of regulator’s and firm’s per period costs is higher than their expected payoffs in the next period. That is, the parties will settle if the difference in their expectations about the appropriate penalty is smaller than the joint future costs. Timing of the settlements depends on the information arrival rates and quality of the information. The higher these rates are – the sooner the estimates will be brought closer to the truth and each other.

Firms' success in negotiating down the "punishment" depends on the stage at which the negotiations concluded. If the firm does not anticipate a big reduction in "punishment" as a result of a formal appeal, it is doubtful how much it would be willing to incur the cost of it. Therefore, most substantial gains are achieved by the firms, who reach the hearing stage. Similarly, negotiations that conclude with formal (rather than informal) settlement result in bigger gains for the firm because per period cost in the formal phase is higher. In other words, grave cases where firms have most convincing arguments and "hard-to-persuade" regulators would self-select themselves into the formal stage. Finally, the amount of "punishment" under the settlement arrangement (formal or informal) in the model depends on the identity of the proposer. If the firm is the proposer more often then it is likely to get better settlement amounts (i.e. bigger reductions in "punishment").

### 3. Empirical Analysis of Regulatory Disputes

The empirical analysis of the regulatory disputes in this section concentrates on the players' choices of negotiation tactics (whether to appeal, settle, and how far to follow the appeals process) and their outcomes in terms of violation type changes, penalty reductions and extensions of the abatement deadlines. 12,190 OSHA health and safety violation histories were collected for a set of pulp and paper mills, oil refineries, and steel mills located in the jurisdiction of federal OSHA. The time span for the analysis is 1990-2000.

The dataset was created using a number of sources<sup>9</sup>. Information on the locations and firm ownership of pulp and paper mills, oil refineries, and steel mills was obtained from corresponding industry directories. Firm-level information on firm employment size, primary business area, and profitability for these establishments was collected from Compustat (Research Insight) database.

Names and addresses of the establishments were then linked to the regulatory information from OSHA Integrated Management Information System (IMIS) using matching algorithm in Gray (1986). OSHA IMIS contains characteristics of the establishments inspected (size of the establishment, whether it is unionized or not, Lost Workday Injury and Illness rates, etc.), information on inspection procedures (scope of inspection, event that triggered the inspection, etc.), violations of OSHA standards cited during an inspection, penalty levels, and abatement deadlines.

Finally, each OSHA violation record has a history of the events associated with it. Violation history typically contains such important milestones as the date of issue of the violation, informal settlement, amendments by OSHA, contest, formal settlement, hearing by ADJ, review by OSHRC, abatement by the establishment, etc. Moreover, apart from the timing of events, one can trace changes in violation type, penalty, and abatement deadlines that these events result in, as negotiations proceed. This key piece of information is a public record, available from official federal OSHA web-site. Downloaded and parsed violation histories were linked to violation records in the sample.

According to the theoretical representation of the problem, the decisions to engage in negotiations, settle, and formally contest depend on the players' expected payoffs (expected "punishment" values net of litigation costs) associated with either option. The actual payoffs are uncertain at the point of making these decisions. However, these actual payoffs are observed in the end of the game and they do depend on the choices made during the game.

Therefore, a following two-stage approach is adopted. First, the reduced-form equation of the negotiations behavior is estimated. Characteristics of violation (initial violation type, penalty, abatement deadline), inspection, establishment, firm and regulator are used as controls

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<sup>9</sup>I wish to thank my advisor Dr Wayne Gray for generously sharing with me most of these industry and regulatory data sources and links.

for the observed heterogeneity of violation histories (i.e. individual negotiation games). The differences in unobserved expected payoffs associated with each negotiation option for either party form the stochastic element of the model.

Second stage of the analysis concentrates on the outcomes of negotiations – changes in violation type, penalty reductions, and abatement deadline extensions. Law and economics scholars have pointed out that there exists a close link between the negotiations behavior and trial outcomes (see Kessler and Rubinfeld (2004)) – for instance, the higher the plaintiff’s probability of winning at trial the lower the probability that the case will be tried. Such selection effects are likely to be present in administrative appeals process as well. The violations, where there exists wide disagreement between the regulator and the firm about the appropriate “punishment”, are more likely to be contested. Therefore, more substantial changes in the initial violation attributes might be observed as a result of an appeal.

To account for the selection effects, the predicted probabilities of informal settlement, formal settlement, and trial from the first part of the analysis are included in the outcome equations, along with other controls for observed heterogeneity, such as initial violation attributes, firm and regulator characteristics. The negotiations outcome equations are estimated using the entire sample of non-negotiated, settled, and tried violations.

### 3.1. Dependent Variables

The dependent variable **CLASS** in the first stage of the analysis codes the four possible negotiation completion stages: violation is not disputed (SQ), dispute is informally settled (IS), violation was contested and settled formally (FS) or went to trial (TR)<sup>10</sup>. Table (1) summarizes the frequency, with which each of the possibilities occur in the analysis sample:

Table 1: Classification of Cases in the Sample

CLASS	Freq	Percent
Non-negotiated cases (SQ)	3,157	25.90
Cases Settled Informally (IS)	5,166	42.38
Cases Settled Formally (FS)	3,332	27.33
Cases Resolved by ADJ or OSHRC (TR)	535	4.39
Total	12,190	100.00

**CLASS** is an unordered polychotomous variable, therefore the econometric approach to the analysis would be trying to predict the probability of a particular violation history ending event. Multinomial Probit (MNP) estimator was chosen to obtain the coefficients for the first-stage reduced form equation of the negotiations behavior<sup>11</sup>. MNP allows for the errors associated with each option to be correlated, which is especially helpful in the present context because unobserved expected payoffs may be interrelated. For example, the expected payoff of the trial is high for the firm due to the substantial unobserved differences between the regulator’s and the firm’s opinions. Then, the expected firm’s payoff of the formal settlement could also be

<sup>10</sup>The analysis sample had only 4 contested violations withdrawn by the firm, 2 dismissed by the government, and none, which went to higher courts. As there are very few violations that achieved the trial stage, they were not split according to whether the final order was ADJ’s finalized decision or a result of the review by OSHRC.

<sup>11</sup>The Independence of Irrelevant Assumption was not supported by the Hausman test, therefore Multinomial Logit (MNP) estimator was ruled out. An alternative way to model a categorical variable is to estimate a sequential Nested Logit model. This might be a natural way to look at the problem, but it also implies that the explanatory variables should be split between different stages for the identification purposes. As there was no obvious way to separate the explanatory variables, this preference was given to MNP estimator.

high, because formal appeal process could demonstrate the seriousness of the firm’s intentions and, thus, grant a potentially higher settlement offer by the regulator.

The analysis of the negotiations’ outcomes involves three aspects: decline in the seriousness of the violation type (or even deletion of the violation), reduction in penalties, and extension of the abatement deadline for the non-deleted violations.

OSHA violations are classified according to increasing degree of seriousness into non-serious, serious, repeat, and willful violations. Serious violations are violations that either involve substantial potential harm to the workers or happen with high probability. Repeat violations are violations of the same standards as in earlier inspections. Willful violations are the ones, for which OSHA intends or was able to prove the employer’s prior knowledge. Table (2) summarizes changes in the initial violation types after negotiations.

Table 2: Cross-Tabulation of the Changes in Violation Type

Final Violation Type	Initial Violation Type				Total
	Other	Serious	Repeat	Willful	
Deleted	151	1,057	85	32	1,325
Other	2,433	655	35	110	3,232
Serious	0	6,577	78	27	6,683
Repeat	0	0	369	8	377
Willful	0	0	0	573	573
Total	2,584	8,289	567	750	12,190

In the estimation sample there are no occurrences of increase in the seriousness of the violation type. Therefore, the following dependent variable was constructed – **VR**= 0 if no change in violation type happened, **VR**= 1 if the seriousness decreased, and **VR**= 2 if the violation was deleted. The estimator employed in the analysis is Ordered Probit, because **VR** an ordered polychotomous variable.

Two alternative dependent variables are used to analyze changes in penalty amounts. First, reduction in the log of penalty **LPR** is formed by subtracting log of the final penalty from the log of the initial penalty (**LP0-LP1**). If the violation was deleted, then log of the final penalty was set to zero. Theoretically, this variable is continuous (with negative values equivalent to penalty increases). However, empirical distribution showed substantial part of the density concentrated at **LPR**= 0. Therefore, to have a robust parameter estimate regardless of the distribution, median regression with bootstrapped standard errors was used along with the usual OLS. Finally, categorical specification of the penalty reduction was employed as well. **PRD** was coded 0 if there was an increase in penalty, 1 if penalty stayed the same, and 2 if the penalty was reduced. The latter equation was estimated using Ordered Probit.

The extension of the abatement deadline was analyzed only for violations that were not deleted as a result of negotiations. The dependent variable **LETABT** was created as difference by subtracting log of workdays to the final abatement deadline from log of workdays to the initial abatement deadline. **LETABT** is clearly a limited dependent variable with the bulk of its distribution at zero. Therefore, Tobit estimate of the equation would be potentially appropriate. However, there is a possibility that the sample of non-deleted violations is not random, which would result in biased estimates.

Unfortunately, Heckman (1976) sample selection model applies only if the dependent variable is Normally distributed. To analyze potential selectivity issue, a binary response model with sample selection was first estimated (see Wooldridge (2000), p. 570 for details). For this analysis the dependent variable **ETABTD** was created, such that **ETABTD**= 0 if

**LETABT** = 0 and **ETABTD** = 1 if **LETABT** > 0. **ETABTD** was set to missing if the violation was deleted. The selection (non-deletion) and **ETABTD** Probit equations were estimated jointly using Partial Maximum Likelihood method.

### 3.2. Independent Variables

Independent variables for the reduced-form model of negotiations behavior can be divided into five groups: initial violation properties, prior information and evidence; case, establishment, firm, and regulator characteristics; and others. Each of the groups is discussed below. Detailed definitions can be found in table (3), descriptive statistics in table (4).

**3.2.1. Initial Violation Properties.** This group includes log of the initially proposed penalty amount (**LP0**); a set of violation type dummies (serious – **VS0**, repeat – **VR0**, willful – **VW0**; non-serious violations are the base group); log of the number of workdays before the hazard has to be abated (**LTABT0**). These variables represent regulator’s initial estimate of the appropriate “punishment” – one of the important exogenous variable in the theory section. Firm’s initial estimate of own compliance status is not observed, but generally, the magnitude of disagreement between the firm and the regulator should be proportional to the size of the initially proposed “punishment”. Thus, more serious the initial regulator’s “guilt” assessment should lead to higher probability of appeal.

Each indicator captures different aspect of the violation. Violation types are broadly based on the associated risk (probability of hazard and magnitude of harm). In addition, a repeat violation indicates that same standards were not complied with in earlier history of the establishment. Willful violation indicated the regulator’s belief that the firm was deliberately non-compliant.

The actual penalty amounts are not completely determined by the violation type – they vary with risk, number of people exposed to the hazard, and number of instances of a particular standard was violated. There are penalty limitations based on the violation type. Non-serious and serious violations cannot have associated penalty higher than 7,000 dollars. However, repeat and willful violations have the limit of 70,000 dollars. Moreover, willful violations can also involve criminal penalties.

Finally, (**LTABT0**) is a “grace” period before the abatement must occur. It varies with the regulator’s estimate of time needed to abate the hazard<sup>12</sup>.

**3.2.2. Case Characteristics.** Generally, the results of an inspection are negotiated as a group. This would imply potential tradeoffs in bargaining process, which were not formally explored in the theory section. However, it seems appropriate to include controls for the “case size”. **LINSP0** is log of total initial penalties in this case, **INSV0** is a number of initial violations proposed after inspection.

**3.2.3. Evidence and Prior Information.** The quality of player’s guesses about the “punishment” as well as the quality and rate at which new evidence arrives were important determinants of the bargaining behavior during administrative appeals process. These characteristics of the negotiations game are difficult to measure. However, a set of proxies was developed.

The variables can be divided into “evidence quality” group and “prior information” group. The quality of the regulator’s evidence, captured by a set of dummies. **COMPR** is 1 if the inspection was “wall-to-wall”. **WALK** is 1 if one of the firm’s employees (often a union representative) walks around with the inspector during the inspection. **INTERV** 1 if the inspector interviewed employees and management. **ABTI** is 1 if the violation was abated “on-the-spot”. **LATE** is 1 if the citation was issued later than the main cohort, for example because test results were late. If the inspector collected a lot of evidence during the inspection then it

<sup>12</sup>Often, however, it coincides with the firm’s contest period of 15 workdays.

is likely that the guess about the true compliance status would be good (i.e. it would have a small variance). Also, given that already so many facts have been uncovered, it is more difficult for the firm to generate evidence for the affirmative defences at low cost – i.e. rate at which new information arrives is low. So, negotiations should be less likely.

The prior information relates to regulator’s and, sometimes, firm’s knowledge about hazards that triggered inspection. Normally, the firm is unaware about an upcoming inspection, but in some OSHA inspection can be anticipated. **RELACC** is 1 if the inspection was triggered by accident. **RELCMP** is 1 if the inspection is a result of the complaint formally filed with OSHA. **RELREF** is 1 if an inspection happened after another government employee observed a safety violation and reported it to OSHA. **ADVNOTE** is 1 an advance notice was issued to the firm about the inspection either due to imminent danger situation or to get the management to the inspection site. These variables as well should decrease the uncertainty of the compliance status estimates.

Finally, the variable **SAFE** is used to control for the domain of the inspection. It is 1 if the inspection was a safety inspection, and 0 – if health. It may not necessarily have anything to do with the information component of the model. However, it is a consensus among OSHA scholars that health violations are harder to detect and prove, because impact of the hazardous conditions on health is spread over time and sometimes does not manifest itself early on.

**3.2.4. Firm Characteristics.** These variables are introduced to control for firm-specific aspects of the bargaining process. They include features of the establishment, where inspection was conducted: **LEMPL** (log of employment size), **UNION** (1 if the establishments’ employees are represented by union), **LWDI** (Lost Workday Illness and Injury rate at the establishment), industry dummies (to control for differences in technologies and, correspondingly, hazards). It is hard to say *a priori* how **LEMPL** is related to the bargaining game – bigger establishments have potentially more things that can go wrong, but, also, there are more people to blame for ignoring firm’s safety rules. **UNION** is important because organized employees are likely to be more influential during firm-regulator negotiations<sup>13</sup>. **LWDI** may be an indicator of firm’s overall compliance status, but it does not imply anything in particular about the violation of the standard in question.

Another set of firm-side variables includes a variety of controls for firm size, area of main business activity, and profitability. **LFEMPL** if log of total number of firm’s employees. **FN-PLTS** is number of establishments belonging to the firm in this industry. **FSIC** is 1 if firm’s primary business activity is in pulp and paper, oil, and steel industry, respectively. **ROA** is firm’s annual return on assets. Potentially firm’s size would make administrative appeals less costly due to economies of scale provided by own legal department. Smaller firms often find themselves in need of hiring a consultant, which may be more expensive. Enterprizes in financial trouble may decide that the opportunity cost of engaging in appeal procedure is too high. Firms with many establishments in the industry may gather useful information about defense strategies and relative success rate of appeals from other establishments in their possession. This may result in better estimates of own true compliance status and potential bargaining gains achievable. Similar argument applies to **FSIC** – firms, which concentrate their activity on the industry in question, may have better information about negotiating with OSHA.

There are four variables which capture firm’s history, including negotiations’ history, with OSHA. They also should affect firm’s (and possibly regulator’s) information quality. There are two kinds of histories collected: one for the establishment, where current violation was cited and another for the other establishments belonging to the same firm. Establishment history affects negotiations directly, because it was created by enforcement-compliance experience and negotiations between the regulator and the firm before current violation was issued. **HCONT**

<sup>13</sup>Employees are allowed to independently contest abatement deadlines, and testify during appeals process.

is establishment’s historical contest rate before the current inspection. **HRPEN** is establishment’s historical percent in the initial penalty paid – this is to measure relative success in negotiations, the higher this measure is, the less successful firm was in bargaining down the penalty. **HVIO** is establishment’s average historical number of proposed violations per inspection. Proposed and not final (sustained by OSHA) violations were chosen in order to compare absolute levels of past compliance, rather than success in firm’s earlier negotiations that was already captured by other variables. Finally, **HNINS** is a number of OSHA inspections that establishment had in the past.

A similar set of variables (**FHCONT**, **FHRPEN**, **FHVIO**, **FHNINS**) was created to represent firm’s history at other establishments prior to the current inspection. These history variables may not be observed by the local regulator, who participates in negotiations. However, introducing the history of the firm at other establishments may help control for the overall firm compliance and negotiations culture (unaffected by the circumstances at the inspected establishment).

**3.2.5. Regulator Characteristics.** Regulator-specific characteristics are calculated for the OSHA Local Area Offices responsible for the establishment in question. Local Area Office is a unit (subdivision of OSHA), which conducts inspections, informal negotiations, receives the Notices of Contest, and presents evidence in the appeals process. The variables gathered relate to Local Area Office’s contest history. **RHCONT** is historical contest rate prior to current inspection in Local Area Office’s jurisdiction. Large values of this variable may reflect an uncooperative approach to regulation. **RHRPEN** is historical percent in the initial penalty paid in the jurisdiction, which measures regulator’s success in past negotiations. **RHVIO** is average historical number of proposed violations per inspection in the jurisdiction. **RHNINS** is a number of inspections that were conducted in the jurisdiction prior to the current inspection.

**3.2.6. Regional Controls.** Regional dummies **NE** (North-East) and **SO** (South), with the Mid-West as the base group were introduced to control for potential higher court biases. Brewster (2004) mentions that judges in the U.S. Circuit Court of Appeals located in the Southern states are more pro-business oriented, while the opposite is true for the judges in the North-East. The West Coast controls are not introduced because federal OSHA does not have jurisdiction over those territories.

Other variables that were included in the models are year dummies and dummies for missing values of **LDWI** and firm characteristics. In addition, the error terms in all the models (with the exception of median regression) were allowed to be correlated for the violations found during the same inspection.

The next section presents the findings of this analysis.

### 3.3. Results

The results discussed in this section are in tables (5) – (9). Variable definitions can be found in table (3) and descriptive statistics in table (4). Table (5) summarizes the results of the reduced-form bargaining behavior model estimated by Multinomial Probit. Joint results for the negotiation outcome models are in table (6). Table (7) contains Ordered Probit estimates of the violation reduction model. Table (8) provides a variety of estimates of the penalty reduction model. Table (9) present abatement deadline extension models.

**3.3.1. Reduced-Form Bargaining Behavior Model – Table (5).** Initial properties of the violation are the most important determinants of the bargaining behavior. Generally, more serious charges lead to higher probability of negotiations. If the firm has reasons to disagree

with the allegations, then incurring costs of an appeal may be optimal because more serious proposed “punishment” has a potential of being reduced to a larger extent.

In particular, 1 percent higher initial penalty results in 5.8 percent higher probability of negotiations and 1.3 percent higher probability of a formal appeal. If initially violation was classified as “serious”, then the firm is approximately 22 percent more likely to negotiate, 14 percent more likely to contest, and 0.8 percent more likely to go to trial (as opposed to a “non-serious” initial classification). If a violation is initially classified as “repeat” or “willful”, probability of an informal settlement decreases, but probability of a formal contest increases by more than 30 percent as compared to non-serious violations. This suggests that the regulator is not inclined to settle more grave violation types informally.

Initial characteristics of the entire case significantly affect firm’s decision to contest. If as a result of inspection, proposed total penalty amount is high – violation belonging to such case is more likely to be contested. 1 percent increase in total proposed penalties increases probability of a given violation to be contested by approximately 14 percent. However, if the number of initial violations detected during inspection increases by 10, then a formal contest is 3 percent less likely.

If lot of evidence was collected during an inspection, then the firm is generally less likely to negotiate. This is consistent with a proposition in the theory section that better “punishment” estimates by the regulator are harder to argue about. For instance, if an inspection was comprehensive, then probability of negotiations decreases approximately by 9.6 percent (as compared to a partial inspection).

However, variables **LATE** and **INTERV** significantly increase probability of a contest. This may be because, all else held constant, exhaustive initial evidence may leave little to argue about informally and, to prove its case, the firm has to engage in formal discovery procedure (i.e. contest). In other words, given that the formal-to-informal cost ratio is fixed, increase in the formal-to-informal rate of information arrival may result in the firm’s choice to contest. In addition, given good initial evidence, the regulator may be hard to persuade to take into account new facts<sup>14</sup>, and, therefore, third-party participation may be beneficial.

Effects of having prior information on the negotiations behavior align with those of evidence variables. Accident caused inspections increase probability of non-negotiating. Complaints decrease probability of informal settlement and increase probability of a contest. Referrals decrease probability of a settlement and increase that of either trial or non-negotiating.

Now turning to the firm-side control effects on the bargaining behavior. Higher **LWDI** rate at the establishment increases probability of informal negotiations and settlement, while unionization status does not have significant effects.

Both, establishment employment, **LEMPL**, and firm total employment, **LFEMPL**, increase probability of a contest. 1 percent increase in the number of employees at the establishment increases probability of a contest by more than 5 percent. 1 percent in total firm employment increases probability of a contest by approximately 4.5 percent. This could be related to potential economies of scale in legal expenditures for bigger enterprises.

Similarly to the establishment and firm employment size, firm profitability also increases probability of a contest. Increase in rate of return on assets by 1 percent increases probability of contest by approximately 2.5 percent, but decreases probability of a trial by 1.1 percent.

More substantial firm presence in the industry increases probabilities of an informal settlement. If firm’s primary business activity is within the industry, to which the inspected establishment belongs, then probability of an informal settlement increases by 1.5 percent. If

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<sup>14</sup>Again, from the theory section – the impact of new information on the “punishment” estimates is smaller if the regulator’s estimate is good. Also, the effect newly arriving information decreases as the amount of information increases.

number of plants owned by the firm in the industry increases by 1, then probability of informal settlement increases by 0.6 percent.

There is not much difference in the effects of the establishment and the firm history with OSHA. The magnitudes of these effects are very small. Firms and establishments that have higher historical contest rate are more likely to contest again. However, firms, whose prior negotiations with OSHA were not successful have lower likelihood of contesting and are more likely to settle informally. If establishment's past ratio of penalty paid to penalty proposed is 10 percent higher then the contest is nearly 1.2 percent less likely. Firms with bad compliance record are less likely to engage in formal contest. Finally, firms that have a longer history with OSHA are more likely to contest (and formally settle).

OSHA Local Area Offices with high historical contest rate in the jurisdiction are more likely to end up contesting, which is a potential indicator of a regulatory rigidity. Local Area Office is historically successful in sustaining initially proposed penalty amounts, then current negotiations are not likely to settle informally and more likely to go through OSHRC. On the other hand, if a jurisdiction normally detects many violations per inspection, then Local Area Office is more likely to either settle informally. Increase in the number of inspections conducted by the Local Area Office in the past also increases probability of an informal settlement.

In the North-Eastern regions of the country, violations less likely to be informally settled (probability of non-negotiating is 2.8 percent higher and probability of a formal appeal is 6.9 percent higher than in the Mid-West). In the Southern regions, violations are 5 percent less likely to be formally settled and 6 percent more likely to go to trial, as compared to Mid-West.

MNP proved to be appropriate in capturing correlations of the unobserved choice shifters. Errors of associated with "informal settlement" and "formal settlement" options are significantly correlated at 67 percent, which could indicate a relationship in expected payoffs for the cases that have a potential to be settled out of court. Errors of "formal settlement" and "trial" options are significantly correlated at 38 percent as well. This could be related to the overall "attractiveness" of a formal appeal option. This also suggests that an attempt to create a sequential model (to be estimated by Nested Logit), could be problematic because the nesting structure is unclear: does the firm decide on whether to settle or on whether to contest in the first stage?

**3.3.2. Negotiation Outcomes – Table (6).** The table presents selected models of the negotiation outcomes. First three columns show the model of decrease in seriousness of the violation, including its deletion. Column *OPROB* contains coefficients of the Ordered Probit model, followed by marginal effects of the variables on the probability of decrease in the seriousness of the violation and marginal effects of the variables on the deletion probability. Next three columns refer to the penalty reduction analysis. Column *QREG* has the results of the median regression estimated for the penalty reduction amounts<sup>15</sup>. Column *ORPOB* shows Ordered Probit estimate of the penalty reduction model, where the dependent variable was transformed into ordered polychotomous form. Column  $P(P_1 < P_0)$  has derived marginal effects of the independent variables on the probability of penalty reduction<sup>16</sup>. Column *SPROB* shows coefficients the binary outcome model with selectivity for the extension of abatement deadline<sup>17</sup>. Last column

<sup>15</sup>Table (8) contains OLS estimated as well, but due to non-continuous shape of **LPR** distribution, median regression estimates are more appropriate.

<sup>16</sup>As the cutoff value that separates "increased penalty" group from the "non-changed penalty" group is not significant, the marginal effects of the independent variables on probabilities to be in these groups are same. Refer to table (8) for the full set of marginal effects.

<sup>17</sup>Table (9) has Tobit estimates of the model in the truncated sample. The dependent variable in this case is actual number of workdays, by which the deadline was extended. However, given that selectivity bias is present in the binary outcome model, the results of the Tobit estimate are suspect.

contains marginal effects on the probability to obtain an extension for abatement deadline in the sample of non-deleted violations.

Probabilities of different options to end a negotiation game were included in the outcome models to address potential self-selection issue. Indeed, increase in likelihood of negotiations significantly changes the initial citation. 10 percent increase in probability that violation is settled informally results in 0.3 percent increase in probability of its deletion, 16 percent increase in the probability of penalty reduction (or 3.6 percent median decrease in penalty), and 0.6 percent increase in probability of abatement deadline extension. The effects of probabilities related to contest are similar in violation type model and penalty reduction model, but they are negative in abatement deadline model.

Among the variables that control for initial citation properties, the type of the initial violation is the most important determinant of the negotiations outcome. Serious violations are 5 percent more likely to be deleted, 19 percent less likely to get a penalty reduction (or are getting 6 percent less in median penalty reductions), 6 percent more likely to get extension of an abatement deadline than non-serious violations. Repeat and willful violations are as well more likely to be deleted (12 percent and 17 percent increase in deletion probability as compared to non-serious violations). However, penalty reductions are obtained more rarely. In addition, violations initially classified as willful, are unlikely to get an abatement deadline extensions. Initial penalty amount has largest impact in the penalty reduction models. 1 percent higher initial penalty results in 8.4 percent reduction in median penalty and 6.9 percent higher probability of getting a penalty reduction. Higher initial penalty increases probability of the violation deletion, but decreases probability of abatement deadline extension. Similarly, initial time to abate is only important in the abatement deadline model – 1 percent longer initial abatement time results in 2.8 percent increase in the probability to get that deadline extended.

Increase in the case total proposed penalties by 1 percent decreases probability of getting a penalty reduction by 9 percent and increases probability of getting an abatement deadline extension by 3 percent. If the number of initially proposed violation in the case increases by 10, then probability of this violation deletion decreases by 0.6 percent, probability of getting a penalty reduction increases by 1.5 percent, and probability of abatement extension declines by 1.2 percent.

Variables that indicate that the regulator has collected a lot of evidence generally have mixed effects on the negotiation outcomes. If the violation was issued later than the main cohort then probability of its deletion declines by 2.6 percent and probability of penalty reduction declines by 17 percent. If an employee was accompanying the inspector during the inspection, then the firm’s chances to get the violation deleted decrease by 2 percent, and probability to get an abatement deadline extension declines by 2.8 percent. If an accident was a trigger for the inspection then getting penalty reduction is 7.3 percent less likely. Notably, if the violation was abated “on-the-spot”, the chance that initial penalties are reduced increases by 20 percent (or 5 percent increase in the median reduction). In cases, when the inspection was “wall-to-wall” or the inspector conducted interviews, however, it seems that the reductions in “punishment” are more likely.

Surprisingly, safety violations are 2.6 percent more likely to be deleted and 2.9 percent more likely to get a penalty reduction than health violations. Another interesting discovery is that violations in unionized places are 2 percent more likely to be deleted and 2.8 percent more likely to get an extension of abatement.

Bigger establishments tend to get larger “punishment” reductions, but not bigger firms. In fact, 1 percent increase in total firm employment results in 3.6 percent lower probability to get a penalty reduction. However, 10 percent increase in return on assets increases chances to get a penalty reduction by 6 percent. There is also some evidence that firms who: concentrate on doing business in the industry; have longer history with OSHA; have had more contests

in the past; and have been less successful in negotiating prior “punishments” – are less likely achieve favorable negotiation outcomes in present.

Regulators characteristics do not matter much in determining outcomes of negotiations. The effects are either insignificant or very small. Establishments in the North-East are 3 percent less likely to get their violation deleted and 2.3 percent less likely to get abatement time extended (as compared to the establishments in the Mid-West). Establishments in the South are getting 0.2 percent larger median penalty reductions per violation, but are also 5.5 less likely to get abatement extension.

### 3.4. Summary

In sum, negotiation behavior seems to be affected by initial properties of the citation; amount of information gathered by the inspector; firm size and profitability. More serious initial “punishment” results in higher probability of negotiations. More thorough inspections lead to “better quality” citations, which are harder for firms to negotiate. This observation aligns with the theoretical analysis, which implies that lower variance of the regulator’s initial appropriate “punishment” estimate makes the regulator less receptive to subsequently arriving (mitigating) information. Larger and more profitable firms and establishments seem to have a comparative advantage in negotiating with OSHA due to economies of scale in legal expenditures.

Negotiation outcomes, however, are primarily determined by the initial properties of the citation. Normally, more serious citation results in more substantial reductions. Controlling for probability of different negotiation outcomes supports the selectivity hypothesis – only the cases, which are likely to result in major decreases of “punishment”, are negotiated.

Prior negotiation history at the establishments has small but significant effects on decisions to negotiate as well as the negotiation outcomes. Firms that contested a lot in the past, are more likely to end up in a formal contest, but will achieve worse results. Firms that were not very successful in negotiating down the penalty, are likely to refrain from the formal contest. Firms with poor compliance record prefer settling the disputes informally.

An interesting finding is that safety violations (as opposed to health violations) get deleted or reclassified more often and their associated penalties reduced more substantially.

Finally, in the North-East, fewer cases get negotiated and outcomes of negotiations are generally less successful for the firm as compared to Mid-West. In the South, more cases go to trial and there is evidence of larger penalty reductions.

## 4. Concluding Remarks

Most studies in the area of regulatory economics maintain the assumption that detection amounts to conviction. In fact, however, enforcement of regulations is equivocal. Monitoring is imperfect. There is room for costly disputes, because the agency must prove that proposed punishments are justifiable.

This paper takes a closer look at the causes and outcomes of the regulatory disputes in the context of Occupational Safety and Health regulations. As a starting point, the following questions were addressed. Which circumstances in the enforcement-compliance scenario result in a dispute? What makes the agency and the regulatee settle the dispute informally? When is formal appeal a preferred firm strategy? What determines the firm’s success in negotiating the “punishment”?

Theoretical analysis was carried out using a sequential bargaining game between the regulator and the firm. Both players are uncertain about the true compliance status and update their estimates based on the additional information that arrives gradually over the course of negotiations.

The key findings are as follows. The firm is more likely to engage in negotiations if the extent of “disagreement” is substantial, bargaining costs are low, rates of new information arrival are high and this information is not too noisy. The parties settle if the difference in their expectations about the appropriate penalty is smaller than the total costs. The firm will file a Notice of Contest versus trying to argue informally if formal to informal negotiations cost ratio is relatively low, but the information arrival rate is higher in the formal phase.

Importantly, if the regulator’s evidence is good (the variance of the regulator’s estimate is small), then the newly arriving information has less impact on the regulator’s belief about the firm’s true compliance status. This may decrease the firm’s willingness to incur the costs of negotiations. However, if the disagreement is substantial and the firm is optimistic about the validity of its affirmative defenses, then the case might go to trial directly, without making attempts to settle in order to save negotiations costs.

The reduction in the initial “punishment” depends on the stage at which the negotiations ended. Given that the firm’s willingness to incur the costs of negotiations depends on how “strong” a case it has, one should expect that firms that go further along in the appeals process get more substantial gains. Also, the amount of “punishment” under the settlement arrangement (formal or informal) in the model depends on the identity of the player, who discovered most of the important facts. If the firm is a proposer more often, then it is likely to get better settlement amounts, i.e. bigger reductions in “punishment”.

The empirical analysis of negotiation strategies outcomes was performed using 12,190 OSHA health and safety violation histories collected for set of pulp and paper mills, oil refineries, and steel mills located in the federal OSHA jurisdiction in 1990-2000.

The reduced-form model of negotiations behavior was used to analyze negotiation tactics employed by the players (whether to appeal, settle, and how far to follow the appeals process). Results suggest that negotiation behavior is affected by initial properties of the citation; amount of information gathered by the inspector; firm size, profitability, and prior history with OSHA. More serious initial “punishment” results in higher probability of negotiations. More thorough inspections lead to “better quality” citations, which are harder for firms to negotiate. This finding offers support for the theoretical conclusion that lower variance of the regulator’s initial appropriate “punishment” estimate makes the regulator less receptive to subsequently arriving (mitigating) information. Larger and more profitable firms and establishments seem to have a comparative advantage in negotiating with OSHA due to economies of scale in legal expenditures.

Negotiation outcomes, however, are primarily determined by the initial properties of the citation – more serious citation results in more substantial reductions. Theoretically implied selectivity bias in cases that go further along the appeal process was supported by empirical evidence.

Surprisingly, safety violations (as opposed to health violations) get deleted or reclassified more often and their associated penalties reduced more substantially. Another interesting discovery is that violations in unionized places are more likely to be either deleted or get an extension of abatement deadline than violations that happened in non-unionized places.

Table 3: Description of Variables

Variable	Description
<b>Violation-level variables</b>	
(Source: OSHA IMIS online violation history files for oil, paper, and steel industry establishments, 1990-2000)	
VS0	1 if the initial violation type if “Serious”
VR0	1 if the initial violation type if “Repeat”
VW0	1 if the initial violation type if “Willful”
V1	the final violation type (0 - “Deleted”, 1 - “Other”, 2 - “Serious”, 3 - “Repeat”, 4 - “Willful”)
VO1	1 if the final violation type if “Other”
VS1	1 if the final violation type if “Serious”
VR1	1 if the final violation type if “Repeat”
VW1	1 if the final violation type if “Willful”
VR	0 if the final violation type did not change, 1 if violation type seriousness decreased, 2 if violation was deleted
P0	initial penalty (000’s of 2000 dollars)
LP0	log of initial penalty P0
P1	final penalty (000’s of 2000 dollars)
LP1	log of final penalty P1
PR	reduction in penalty (P1-P0)
LPR	difference in logged penalties (LP1-LP0)
PRD	0 if penalty increased, 1 if penalty stayed same, 2 if penalty decreased
TABT0	time from violation issue date to initial abatement deadline (workdays)
TABT1	time from violation issue date to final abatement deadline for non-deleted violations (workdays)
ETABT	extension of the abatement deadline for non-deleted violations (workdays, TABT1-TABT0)
ETABTD	1 if the extension of the abatement deadline was obtained for non-deleted violations
LTABT0	log of TABT0
LTABT1	log of TABT1
LETABT	difference in logged times to abate (LTABT1-LTABT0)
LATE	1 if the violation was issued later than the first series of citations
ABTI	1 if the violation was abated immediately during the course of inspection
PMA	1 if the firm filed a Petition to Modify Abatement
AMD	1 if the Area Director amended the violation
PIS	predicted probability of the informal settlement using MNP model
PFS	predicted probability of the formal settlement using MNP model
PTR	predicted probability of going to trial using MNP model
<b>Inspection-level variables</b>	
(Source: OSHA IMIS STEM files for oil, paper, and steel industry establishments, 1990-2000)	
SAFETY	1 if inspection was a safety inspection, 0 – if health
COMPR	1 if inspection was full scope
WALK	1 if the firm’s employee was accompanying the inspector during the inspection
INTERV	1 if the employees were interviewed
ADVNOTE	1 if an establishment received an advance notice of the inspection from the regulator

Continued on next page

Table 3 – continued from previous page

Variable	Description
RELACC	1 if the inspection was result of an accident
RELCMP	1 if the inspection was triggered by a complaint
RELREF	1 if the inspection was triggered by a referral
LINSP0	log of total initial penalties for the inspection
INSV0	initial number of violations detected during inspection
LEMP0	log of the number of employees on site during an inspection
LFEMPL	log of employees at the firm that owns the establishment at the time of inspection
UNION	1 if the establishment is unionized during the time of inspection
LWDI	Lost Workday Injury and Illness rate
HCONT	percent of inspections that had a contest in the establishment's history prior to the current inspection
HPENR	average percent of initial penalty paid by the establishment prior to the current inspection
HVIO	proposed average number of violated standards per inspection for the establishment prior to the current inspection
HNINSP	number of inspections that the establishment had prior to the current inspection
FHCONT	percent of inspections that had a contest in the firm's history at other establishments prior to the current inspection
FHPENR	average percent of initial penalty paid by the firm at other establishments prior to the current inspection
FHVIO	proposed average number of violated standards per inspection in the firm's history at other establishments prior to the current inspection
FHNINSP	number of inspections that the firm had prior to the current inspection at other establishments
RHCONT	percent of inspections that had a contest in the history of the OSHA local area office prior to the current inspection
RHPENR	average percent of initial penalty paid by the firms inspected by the OSHA local area office prior to the current inspection
RHVIO	proposed average number of violated standards per inspection detected by the OSHA local area office prior to the current inspection
RHNINSP	number of inspections carried out by the OSHA local area office prior to the current inspection
NE	1 if the establishment is located in the North-East of the continental U.S. (CT, DE, MA, ME, NH, NJ, NY, PA, VT, WV)
SO	1 if the establishment is located in the South of the continental U.S. (AL, AR, FL, GA, LA, MS, OK, TX)
S	1 if the establishment is a steel mill (SIC 3312)
O	1 if the establishment is an oil refinery (SIC 2911)

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Table 3 – continued from previous page

Variable	Description
<b>Firm-level variables</b>	
(Source: Compustat and Industry Directories, 1990-2000)	
FNPTS	number of the establishments in the industry that belong to the firm in the year of inspection
FSIC	1 if the firm's primary SIC coincides with the industry SIC in the year of inspection
ROA	firm's return on assets (in percent) in the year of inspection

Table 4: Descriptive Statistics

VAR	MEAN	SD	MEDIAN	MIN	MAX	N
VS0	0.6799	0.4665	1	0	1	12190
VR0	0.0465	0.2106	0	0	1	12190
VW0	0.0615	0.2403	0	0	1	12190
VO1	0.2652	0.4415	0	0	1	12190
VS1	0.5482	0.4977	1	0	1	12190
VR1	0.0309	0.1731	0	0	1	12190
VW1	0.0470	0.2117	0	0	1	12190
VRD0	0.8163	0.3872	1	0	1	12190
VRD1	0.0750	0.2634	0	0	1	12190
VRD2	0.1087	0.3113	0	0	1	12190
P0	3.2932	19.4195	0.8029	0	1386.2420	12190
LP0	4.9665	3.6910	6.6894	0	14.1421	12190
P1	1.9833	18.7489	0.2195	0	1406.7950	12190
LP1	3.861194	3.635088	5.395953	0	14.15683	12190
PR	1.3099	4.5158	0.0750	-45.2961	69.6342	12190
LPR	1.105332	2.490693	.1508994	-10.5099	11.15102	12190
PRD0	0.0559	0.2298	0	0	1	12190
PRD1	0.4291	0.4950	0	0	1	12190
PRD2	0.5149	0.4998	1	0	1	12190
TABT0	21.5633	28.5569	17	0	502	12190
TABT1	33.2025	59.1188	21	0	960	10865
ETABT	11.4561	50.2632	0	0	935	10865
ETABTD	0.2205	0.4146	0	0	1	12190
LTABT0	2.6238	1.0023	2.8904	0	6.2206	12190
LTABT1	2.8023	1.1743	3.0910	0	6.8680	10865
LETABT	0.4498	1.3097	0	0	6.8416	10865
LATE	0.0993	0.2991	0	0	1	12190
ABTI	0.0331	0.1788	0	0	1	12190
PMA	0.0171	0.1298	0	0	1	12190
AMD	0.0064	0.0797	0	0	1	12190
SAFETY	0.6792	0.4668	1	0	1	12190
COMPR	0.4818	0.4997	0	0	1	12190
WALK	0.6796	0.4667	1	0	1	12190
INTERV	0.0886	0.2842	0	0	1	12190
ADVNOTE	0.0358	0.1859	0	0	1	12190
RELACC	0.0753	0.2639	0	0	1	12190
RELCMP	0.1292	0.3354	0	0	1	12190
RELREF	0.0339	0.1809	0	0	1	12190
LINSPO	9.6182	2.5592	9.5493	0	15.6825	12190
INSV0	40.6762	76.2876	17	1	409	12190
LEMPL	6.1030	1.2888	6.3117	0.6931	10.5967	12190
UNION	0.8627	0.3442	1	0	1	12190
LWDI	15.0012	36.2404	0	0	257	2614
FNPTS	8.3312	10.5867	4	1	41	12190
FSIC	0.8050	0.3962	1	0	1	5667
ROA	2.8407	4.3120	2.6710	-38.8980	19.5850	5411

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Table 4 – continued from previous page

VAR	MEAN	SD	MEDIAN	MIN	MAX	N
LFEMPL	8.0923	2.1223	8.3154	0	13.1223	12190
HCONT	13.1578	13.6788	11.1111	0	100	11842
HRPEN	93.8446	18.9527	100	0	101.5723	11842
HVIO	5.6111	4.4460	4.25	0	39	11842
HNINSP	19.6504	22.8976	13	1	167	11842
FHCONT	16.5280	17.971	15	0	100	7048
FHRPEN	93.7832	23.6453	100	0	103.7159	7048
FHVIO	5.4980	6.8301	4	0	50.1666	7048
FHNINSP	27.2180	41.3424	9	1	153	7048
RHCONT	14.7264	10.3415	11.8143	0	100	12190
RHRPEN	94.1171	12.7591	99.8480	0	100.876	12190
RHVIO	4.8644	2.3942	4.5517	0	18	12190
RHNINSP	159.2297	121.2925	159	0	572	12190
NE	0.3617	0.4805	0	0	1	12190
SO	0.2513	0.4338	0	0	1	12190
S	0.2396	0.4269	0	0	1	12190
O	0.1795	0.3838	0	0	1	12190
PIS	50.8498	27.3879	39.1314	0.0833	99.3646	12190
PFS	22.5247	27.8955	17.0868	0.0002	99.8287	12190
PTR	5.5533	10.6808	0.4604	0.0000	90.5365	12190

Source: OSHA IMIS, 1990-2000 and Compustat (Research Insight)

Table 5: Multinomial Probit Estimates of the Negotiations Strategy

	Coefficients, SQ is a base group			Marginal Effects			
	IS	FS	TR	SQ	IS	FS	TR
LP0	0.2104*** (0.0071)	0.1382*** (0.0077)	0.0878*** (0.0104)	-0.0579*** (0.0015)	0.0430*** (0.0019)	0.0120*** (0.0016)	0.0009*** (0.0002)
VS0 (d)	0.9691*** (0.0659)	8.8734* (4.8230)	65.8991*** (10.6227)	-0.2172*** (0.0214)	0.0734*** (0.0210)	0.1362*** (0.0276)	0.0075* (0.0045)
VR0 (d)	0.9425*** (0.1657)	15.5758* (8.6399)	49.6862*** (17.8354)	-0.1555*** (0.0212)	-0.1825 (0.1407)	0.3290** (0.1538)	0.0091 (0.0074)
VW0 (d)	1.4406*** (0.2593)	17.6444* (9.8130)	103.3301*** (16.4840)	-0.1951*** (0.0236)	-0.1862 (0.1591)	0.3449** (0.1710)	0.0366** (0.0155)
LTABT0	-0.0222 (0.0223)	0.1111*** (0.0253)	-0.0357 (0.0371)	-0.0062 (0.0050)	-0.0237*** (0.0055)	0.0310*** (0.0050)	-0.0012 (0.0007)
LINSPO	0.5494*** (0.0331)	8.1959* (4.3550)	23.1875*** (5.2740)	-0.1198*** (0.0062)	-0.0262*** (0.0085)	0.1433*** (0.0069)	0.0028*** (0.0006)
INSVO	-0.0074*** (0.0009)	-0.1638* (0.0906)	-1.0425*** (0.1105)	0.0017*** (0.0002)	0.0013*** (0.0002)	-0.0029*** (0.0002)	-0.0001*** (0.0000)
LATE (d)	0.8622*** (0.1063)	16.2173* (8.8882)	68.0308*** (13.3355)	-0.1553*** (0.0215)	-0.1964 (0.1341)	0.3364** (0.1470)	0.0152* (0.0090)
ABTI (d)	-0.9326*** (0.1571)	-2.1408 (1.7014)	20.9540 (15.5249)	0.2091*** (0.0446)	-0.1864*** (0.0423)	-0.0269 (0.0261)	0.0042 (0.0043)
COMPR (d)	-0.4969*** (0.0621)	-1.1776 (0.7441)	-21.3915*** (7.8589)	0.0962*** (0.0152)	-0.0807*** (0.0158)	-0.0123 (0.0117)	-0.0030 (0.0021)
WALK (d)	-0.1151* (0.0630)	0.6588 (0.7860)	36.2416*** (10.1603)	0.0202* (0.0122)	-0.0370** (0.0162)	0.0120 (0.0124)	0.0047 (0.0030)
INTERV (d)	-0.0569 (0.1956)	9.4524 (5.8007)	-17.9651 (22.6340)	-0.0182 (0.0361)	-0.1863** (0.0827)	0.2072** (0.0933)	-0.0028 (0.0026)
ADVNOTE (d)	-1.0177*** (0.1755)	10.3506 (6.4680)	9.8440 (21.3374)	0.1284*** (0.0349)	-0.3749*** (0.1039)	0.2460*** (0.1095)	0.0006 (0.0033)
RELACC (d)	-0.2585* (0.1375)	-1.8663 (1.9561)	8.0411 (12.2959)	0.0555* (0.0303)	-0.0265 (0.0350)	-0.0304 (0.0290)	0.0015 (0.0023)
RELCMP (d)	-0.0192 (0.0821)	5.6945* (3.3490)	25.1021*** (8.3031)	-0.0106 (0.0148)	-0.1081*** (0.0446)	0.1146*** (0.0419)	0.0040 (0.0026)
RELREF (d)	-0.3531** (0.1413)	-5.1822* (3.0715)	71.3969*** (14.7593)	0.0831** (0.0330)	-0.0182 (0.0339)	-0.0896*** (0.0232)	0.0248** (0.0103)
SAFETY (d)	-0.0526 (0.0528)	-0.4569 (0.6314)	1.5303 (6.2084)	0.0108 (0.0102)	-0.0031 (0.0130)	-0.0078 (0.0110)	0.0003 (0.0010)
LWDI	0.0082*** (0.0019)	-0.0984 (0.0670)	-0.3184 (0.2023)	-0.0013*** (0.0004)	0.0034*** (0.0006)	-0.0020*** (0.0006)	0.0000 (0.0000)
UNION (d)	0.1305 (0.0846)	0.7601 (1.0905)	-16.2041 (10.7715)	-0.0268 (0.0174)	0.0162 (0.0222)	0.0133 (0.0187)	-0.0028 (0.0025)
LEMPL	-0.0586** (0.0253)	2.8295* (1.6748)	0.1597 (2.7272)	0.0054 (0.0048)	-0.0594*** (0.0063)	0.0542*** (0.0054)	-0.0002 (0.0004)
LFEMPL	0.1137*** (0.0410)	2.3993* (1.3792)	-18.1522*** (5.2697)	-0.0262*** (0.0081)	-0.0154 (0.0113)	0.0445*** (0.0105)	-0.0029*** (0.0007)
ROA	-0.1620* (0.0945)	1.4409 (1.3153)	-84.5339*** (13.2022)	0.0277 (0.0189)	-0.0517** (0.0244)	0.0354* (0.0204)	-0.0112* (0.0062)
FNPTS	-0.0146*** (0.0052)	-0.5807* (0.3115)	4.9776*** (0.8250)	0.0039*** (0.0010)	0.0063*** (0.0013)	-0.0110*** (0.0011)	0.0008*** (0.0001)
FSIC (d)	0.0048 (0.0091)	-0.8801* (0.5079)	8.5626*** (1.3831)	0.0008 (0.0017)	0.0151*** (0.0023)	-0.0172*** (0.0019)	0.0013*** (0.0002)

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Table 5 – continued from previous page

	Coefficients, SQ is a base group			Marginal Effects			
	IS	FS	TR	SQ	IS	FS	TR
HCONT	0.0109*** (0.0019)	0.0256*** (0.0022)	0.0116*** (0.0028)	-0.0039*** (0.0004)	-0.0007 (0.0005)	0.0046*** (0.0004)	-0.0000 (0.0000)
HRPEN	-0.0015 (0.0012)	-0.0057*** (0.0014)	-0.0017 (0.0018)	0.0007** (0.0003)	0.0004 (0.0003)	-0.0012*** (0.0003)	0.0000 (0.0000)
HVIO	0.0342*** (0.0064)	-0.0313*** (0.0068)	-0.0035 (0.0094)	-0.0077*** (0.0014)	0.0058*** (0.0016)	-0.0025 (0.0013)	-0.0006** (0.0002)
HNINSP	0.0069*** (0.0015)	0.0118*** (0.0018)	0.0009 (0.0025)	-0.0020*** (0.0003)	0.0003 (0.0004)	0.0018*** (0.0004)	-0.0001* (0.0000)
FHCONT	0.0083*** (0.0019)	0.0181*** (0.0022)	0.0171*** (0.0027)	-0.0029*** (0.0004)	-0.0004 (0.0004)	0.0031*** (0.0004)	0.0002*** (0.0000)
FHRPEN	0.0003 (0.0012)	-0.0055*** (0.0015)	-0.0154*** (0.0033)	0.0005 (0.0003)	0.0011*** (0.0003)	-0.0013*** (0.0003)	-0.0003*** (0.0001)
FHVIO	0.0100* (0.0043)	-0.0051 (0.0057)	0.0035 (0.0075)	-0.0011 (0.0010)	0.0039** (0.0012)	-0.0028* (0.0013)	0.0000 (0.0001)
FHNINSP	-0.0058*** (0.0017)	0.0166*** (0.0018)	-0.0167*** (0.0032)	-0.0005 (0.0004)	-0.0042*** (0.0004)	0.0051*** (0.0004)	-0.0004*** (0.0001)
RHCONT	-0.0078** (0.0027)	0.0066** (0.0024)	0.0131*** (0.0032)	0.0005 (0.0005)	-0.0035*** (0.0007)	0.0027*** (0.0006)	0.0003*** (0.0001)
RHRPEN	-0.0102*** (0.0018)	0.0024 (0.0022)	0.0114*** (0.0031)	0.0012** (0.0004)	-0.0036*** (0.0005)	0.0021*** (0.0005)	0.0003*** (0.0001)
RHVIO	-0.0160 (0.0130)	-0.0621*** (0.0137)	0.1085*** (0.0205)	0.0071** (0.0027)	0.0037 (0.0036)	-0.0135*** (0.0031)	0.0027*** (0.0005)
RHNINSP	0.0009*** (0.0002)	0.0000 (0.0002)	0.0003 (0.0004)	-0.0001** (0.0000)	0.0003*** (0.0001)	-0.0001** (0.0001)	-0.0000 (0.0000)
NE (d)	-0.1910*** (0.0642)	3.4122 (2.0785)	8.5827 (9.9442)	0.0286** (0.0122)	-0.0979*** (0.0233)	0.0681*** (0.0205)	0.0011 (0.0017)
SO (d)	0.1218 (0.0893)	-1.4703 (1.3153)	146.5901*** (14.0297)	-0.0208 (0.0170)	0.0111 (0.0255)	-0.0537*** (0.0179)	0.0623*** (0.0219)
S (d)	0.0151 (0.0812)	-6.4465* (3.7783)	87.2938*** (10.8546)	0.0077 (0.0161)	0.0873*** (0.0219)	-0.1201*** (0.0213)	0.0251** (0.0120)
O (d)	-0.0199 (0.1049)	0.6578 (1.1893)	78.0018*** (11.0774)	0.0022 (0.0203)	-0.0271 (0.0261)	0.0026 (0.0200)	0.0219* (0.0118)
CONST	0.3092 (0.3121)	-60.4504 (34.8655)	-59.8172 (40.6785)				
Pred. Prob.				0.2108	0.5084	0.2252	0.0555
$\rho_{IS,FS}$	0.6732*** (0.1021)						
$\rho_{IS,TR}$	0.8068 (0.2013)						
$\rho_{FS,TR}$	0.3807** (0.1400)						
NOBS	48760						
NCASE	12190						
LL	-9491.2680						

Source: OSHA IMIS violation block files, 1990-2000

Significance: \* – 0.1, \*\* – 0.05, \*\*\* – 0.01

Standard errors are adjusted for clustering of the residuals at the inspection level.

Table 6: Outcomes of Negotiations

	Violation Type Change			Penalty Reduction			Abt. Deadline Extension	
	OPROB	$P(V_1 < V_0)$	$P(V_1 = 0)$	QREG	OPROB	$P(P_1 < P_0)$	SPROB	$P(T_1 > T_0)$
PIS	0.0027* (0.0012)	0.0002	0.0003	0.0036*** (0.0006)	0.0399*** (0.0009)	0.0159	0.0037** (0.0013)	0.0006
PFS	0.0094*** (0.0024)	0.0008	0.0012	0.0010*** (0.0002)	0.0341*** (0.0018)	0.0136	-0.0058* (0.0028)	-0.0008
PTR	0.0099*** (0.0026)	0.0009	0.0012	0.0010*** (0.0003)	0.0254*** (0.0021)	0.0101	-0.0071* (0.0033)	-0.0011
LP0	0.0204* (0.0084)	0.0018	0.0025	0.0845*** (0.0024)	0.1753*** (0.0075)	0.0698	-0.0403*** (0.0110)	-0.0060
VS0 (d)	0.4831*** (0.0698)	0.0399	0.0535	-0.0608*** (0.0095)	-0.4851*** (0.0485)	-0.1896	0.4449*** (0.0778)	0.0668
VR0 (d)	0.6574*** (0.0996)	0.0611	0.1249	0.0511** (0.0158)	-0.1069 (0.0813)	-0.0426	0.4610*** (0.1248)	0.1032
VW0 (d)	0.8556*** (0.1209)	0.0770	0.1781	-0.0116 (0.0515)	-0.2082* (0.0930)	-0.0829	0.1660 (0.1588)	0.0289
LTABT0	0.0256 (0.0165)	0.0023	0.0031	-0.0008 (0.0010)	-0.0210 (0.0130)	-0.0084	0.1898*** (0.0192)	0.0281
LINSP0	0.0061 (0.0317)	0.0005	0.0008	-0.0033*** (0.0006)	-0.2339*** (0.0237)	-0.0931	0.1751*** (0.0384)	0.0283
INSV0	-0.0051*** (0.0008)	-0.0004	-0.0006	0.0004*** (0.0001)	0.0039*** (0.0005)	0.0015	-0.0071*** (0.0011)	-0.0012
LATE (d)	-0.2427** (0.0841)	-0.0201	-0.0261	-0.0327*** (0.0083)	-0.4339*** (0.0625)	-0.1707	-0.0069 (0.0977)	-0.0031
ABTI (d)	-0.0961 (0.0772)	-0.0082	-0.0112	0.0506*** (0.0120)	0.5259*** (0.0685)	0.1980	-	-
COMPR (d)	0.0103 (0.0399)	0.0009	0.0013	0.0023 (0.0035)	0.2479*** (0.0310)	0.0984	-	-
WALK (d)	-0.1682*** (0.0421)	-0.0150	-0.0220	-0.0060* (0.0028)	0.0471 (0.0332)	0.0187	-0.1322** (0.0449)	-0.0213
INTERV (d)	0.2752** (0.0877)	0.0254	0.0407	0.0196 (0.0228)	0.1051 (0.0771)	0.0417	-0.1562*** (0.0469)	-0.0281
ADVNOTE (d)	0.6110*** (0.0894)	0.0571	0.1139	0.0085 (0.0191)	0.0891 (0.0780)	0.0353	0.3295** (0.1078)	0.0688
RELACC (d)	0.0138 (0.0664)	0.0012	0.0017	-0.0733*** (0.0188)	-0.1835** (0.0601)	-0.0731	0.1900 (0.1360)	0.0488
RELCMP (d)	0.0329 (0.0477)	0.0029	0.0042	-0.0029 (0.0035)	-0.0546 (0.0395)	-0.0218	0.0144 (0.0880)	0.0024
							0.2263*** (0.0572)	0.0424

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Table 6 – continued from previous page

	Violation Type Change			Penalty Reduction			Abt. Deadline Extension	
	OPROB	P(V <sub>1</sub> < V <sub>0</sub> )	P(V <sub>1</sub> = 0)	QREG	OPROB	P(P <sub>1</sub> < P <sub>0</sub> )	SPROB	P(T <sub>1</sub> > T <sub>0</sub> )
RELREF (d)	-0.0013 (0.0821)	-0.0001	-0.0002	-0.0183 (0.0112)	0.1767* (0.0704)	0.0697	0.0375 (0.0948)	0.0059
SAFETY (d)	-0.1969*** (0.0323)	-0.0176	-0.0260	0.0010 (0.0024)	0.0732** (0.0266)	0.0291	-0.0410 (0.0382)	-0.0088
LWDI	0.0012 (0.0010)	0.0001	0.0001	-0.0009*** (0.0002)	-0.0054*** (0.0008)	-0.0021	0.0003 (0.0010)	0.0001
UNION (d)	0.1975*** (0.0570)	0.0166	0.0221	0.0029 (0.0040)	-0.0894* (0.0443)	-0.0355	0.1835** (0.0646)	0.0283
LEMPL	0.0367* (0.0158)	0.0032	0.0046	0.0043** (0.0015)	0.0306* (0.0127)	0.0122	0.0386* (0.0192)	0.0068
LFEMPL	0.0171 (0.0279)	0.0015	0.0021	-0.0047* (0.0024)	-0.0911*** (0.0227)	-0.0363	0.0798* (0.0325)	0.0126
ROA	-0.0035 (0.0056)	-0.0003	-0.0004	0.0017*** (0.0004)	0.0161*** (0.0047)	0.0064	0.0168* (0.0072)	0.0026
FNPTS	0.0021 (0.0040)	0.0002	0.0003	-0.0013*** (0.0004)	-0.0131*** (0.0031)	-0.0052	-0.0005 (0.0044)	-0.0001
FSIC (d)	-0.2728*** (0.0584)	-0.0244	-0.0360	0.0044 (0.0044)	-0.1953*** (0.0476)	-0.0777	-0.3058*** (0.0629)	-0.0444
HCONT	-0.0029* (0.0014)	-0.0003	-0.0003	-0.0004** (0.0001)	-0.0042*** (0.0012)	-0.0017	0.0019 (0.0017)	0.0003
HRPEN	-0.0017* (0.0008)	-0.0002	-0.0002	-0.0001* (0.0001)	-0.0024*** (0.0007)	-0.0010	-0.0063*** (0.0012)	-0.0009
HVIO	-0.0070 (0.0050)	-0.0006	-0.0009	-0.0053*** (0.0012)	-0.0166*** (0.0039)	-0.0066	0.0023 (0.0050)	0.0003
HNINSP	0.0011 (0.0009)	0.0001	0.0001	-0.0003*** (0.0001)	-0.0019* (0.0008)	-0.0008	0.0013 (0.0012)	0.0002
FHCONT	0.0026* (0.0013)	0.0002	0.0003	0.0005*** (0.0001)	0.0017 (0.0011)	0.0007	0.0063*** (0.0015)	0.0009
FHRPEN	-0.0027** (0.0010)	-0.0002	-0.0003	-0.0001** (0.0001)	-0.0024*** (0.0007)	-0.0010	-0.0020* (0.0010)	-0.0003
FHVIO	-0.0168*** (0.0039)	-0.0015	-0.0021	0.0004 (0.0003)	-0.0058* (0.0028)	-0.0023	0.0037 (0.0035)	0.0005
FHNINSP	-0.0015 (0.0014)	-0.0001	-0.0002	-0.0008*** (0.0002)	-0.0036** (0.0011)	-0.0014	-0.0003 (0.0018)	-0.0001

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Table 6 – continued from previous page

	Violation Type Change			Penalty Reduction			Abt. Deadline Extension	
	OPROB	P(V <sub>1</sub> < V <sub>0</sub> )	P(V <sub>1</sub> = 0)	QREG	OPROB	P(P <sub>1</sub> < P <sub>0</sub> )	SPROB	P(T <sub>1</sub> > T <sub>0</sub> )
RHCONT	0.0016 (0.0017)	0.0001	0.0002	0.0003* (0.0001)	0.0033* (0.0014)	0.0013	-0.0009 (0.0021)	-0.0001
RHRPEN	-0.0006 (0.0013)	-0.0000	-0.0001	-0.0004*** (0.0001)	0.0012 (0.0011)	0.0005	-0.0053*** (0.0015)	-0.0008
RHVIO	-0.0085 (0.0096)	-0.0008	-0.0010	0.0013 (0.0008)	0.0053 (0.0075)	0.0021	0.0090 (0.0108)	0.0013
RHNINSP	-0.0006*** (0.0001)	-0.0001	-0.0001	-0.0001*** (0.0000)	-0.0005*** (0.0001)	-0.0002	-0.0004* (0.0002)	-0.0001
NE (d)	-0.2679*** (0.0419)	-0.0230	-0.0318	-0.0222*** (0.0056)	0.0569 (0.0324)	0.0226	-0.1273** (0.0458)	-0.0228
SO (d)	-0.0702 (0.0584)	-0.0061	-0.0085	0.0022* (0.0015)	0.0749 (0.0473)	0.0298	-0.3909*** (0.0706)	-0.0549
S (d)	0.2479*** (0.0542)	0.0225	0.0342	-0.0017 (0.0037)	-0.0676 (0.0436)	-0.0269	-0.2968*** (0.0666)	-0.0397
O (d)	0.3356*** (0.0566)	0.0308	0.0494	-0.0232*** (0.0057)	-0.0963* (0.0471)	-0.0384	0.3458*** (0.0729)	0.0739
CUT1	2.2457*** (0.2164)				0.2814 (0.1612)			
CUT2	2.6491*** (0.2167)				2.1804*** (0.1620)			
CONST				0.0027 (0.0150)			-1.9511*** (0.2388)	
ATHRHO							0.6615* (0.3660)	
LL	-6193.569				-8378.014		-6987.127	
R2	0.155			0.335	0.206			
N	12190			12190	12190		12190	

Source: OSHA IMIS, 1990-2000

Significance: \* – 0.1, \*\* – 0.05, \*\*\* – 0.01

Standard errors are adjusted for clustering of the residuals at the inspection level.

Table 7: Reduction in Violation Type Severity

	VR OPROBIT	VR P(V1=V0)	VR P(V1<V0)	VR P(V1=0)
PIS	0.0027* (0.0012)	-0.0006	0.0002	0.0003
PFS	0.0094*** (0.0024)	-0.0020	0.0008	0.0012
PTR	0.0099*** (0.0026)	-0.0021	0.0009	0.0012
LP0	0.0204* (0.0084)	-0.0043	0.0018	0.0025
VS0 (d)	0.4831*** (0.0698)	-0.0934	0.0399	0.0535
VR0 (d)	0.6574*** (0.0996)	-0.1860	0.0611	0.1249
VW0 (d)	0.8556*** (0.1209)	-0.2551	0.0770	0.1781
LTABT0	0.0256 (0.0165)	-0.0054	0.0023	0.0031
LINSP0	0.0061 (0.0317)	-0.0013	0.0005	0.0008
INSV0	-0.0051*** (0.0008)	0.0011	-0.0004	-0.0006
LATE (d)	-0.2427** (0.0841)	0.0462	-0.0201	-0.0261
ABTI (d)	-0.0961 (0.0772)	0.0195	-0.0082	-0.0112
COMPR (d)	0.0103 (0.0399)	-0.0022	0.0009	0.0013
WALK (d)	-0.1682*** (0.0421)	0.0371	-0.0150	-0.0220
INTERV (d)	0.2752** (0.0877)	-0.0661	0.0254	0.0407
ADVNOTE (d)	0.6110*** (0.0894)	-0.1710	0.0571	0.1139
RELACC (d)	0.0138 (0.0664)	-0.0029	0.0012	0.0017
RELCMP (d)	0.0329 (0.0477)	-0.0071	0.0029	0.0042
RELREF (d)	-0.0013 (0.0821)	0.0003	-0.0001	-0.0002
SAFETY (d)	-0.1969*** (0.0323)	0.0436	-0.0176	-0.0260
LWDI	0.0012 (0.0010)	-0.0002	0.0001	0.0001
UNION (d)	0.1975*** (0.0570)	-0.0388	0.0166	0.0221
LEMPL	0.0367* (0.0158)	-0.0078	0.0032	0.0046
LFEMPL	0.0171 (0.0279)	-0.0036	0.0015	0.0021

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Table 7 – continued from previous page

	VR OPROBIT	VR P(V1=V0)	VR P(V1<V0)	VR P(V1=0)
ROA	-0.0035 (0.0056)	0.0008	-0.0003	-0.0004
FNPTS	0.0021 (0.0040)	-0.0005	0.0002	0.0003
FSIC (d)	-0.2728*** (0.0584)	0.0604	-0.0244	-0.0360
HCONT	-0.0029* (0.0014)	0.0006	-0.0003	-0.0003
HRPEN	-0.0017* (0.0008)	0.0004	-0.0002	-0.0002
HVIO	-0.0070 (0.0050)	0.0015	-0.0006	-0.0009
HNINSP	0.0011 (0.0009)	-0.0002	0.0001	0.0001
FHCONT	0.0026* (0.0013)	-0.0005	0.0002	0.0003
FHRPEN	-0.0027** (0.0010)	0.0006	-0.0002	-0.0003
FHVIO	-0.0168*** (0.0039)	0.0035	-0.0015	-0.0021
FHNINSP	-0.0015 (0.0014)	0.0003	-0.0001	-0.0002
RHCONT	0.0016 (0.0017)	-0.0003	0.0001	0.0002
RHRPEN	-0.0006 (0.0013)	0.0001	-0.0000	-0.0001
RHVIO	-0.0085 (0.0096)	0.0018	-0.0008	-0.0010
RHNINSP	-0.0006*** (0.0001)	0.0001	-0.0001	-0.0001
NE (d)	-0.2679*** (0.0419)	0.0548	-0.0230	-0.0318
SO (d)	-0.0702 (0.0584)	0.0147	-0.0061	-0.0085
S (d)	0.2479*** (0.0542)	-0.0567	0.0225	0.0342
O (d)	0.3356*** (0.0566)	-0.0802	0.0308	0.0494
CUT1	2.2457*** (0.2164)			
CUT2	2.6491*** (0.2167)			
LL	-6193.569			
R2	0.155			
N	12190			

Source: OSHA IMIS, 1990-2000

Significance: \* – 0.1, \*\* – 0.05, \*\*\* – 0.01. Standard errors are adjusted for clustering of the residuals at the inspection level.

Table 8: Penalty Reduction Analysis

	RLP OLS	RLP QREG	RPD OPROBIT	RPD P(P1>P0)	RPD P(P1=P0)	RPD P(P1<P0)
PIS	0.0339*** (0.0032)	0.0036*** (0.0006)	0.0399*** (0.0009)	-0.0023	-0.0136	0.0159
PFS	0.0149*** (0.0037)	0.0010*** (0.0002)	0.0341*** (0.0018)	-0.0020	-0.0116	0.0136
PTR	0.0126** (0.0040)	0.0010*** (0.0003)	0.0254*** (0.0021)	-0.0015	-0.0086	0.0101
LP0	0.3636*** (0.0131)	0.0845*** (0.0024)	0.1753*** (0.0075)	-0.0093	-0.0605	0.0698
VS0 (d)	-0.5961*** (0.0971)	-0.0608*** (0.0095)	-0.4851*** (0.0485)	0.0245	0.1651	-0.1896
VR0 (d)	0.2301 (0.1413)	0.0511** (0.0158)	-0.1069 (0.0813)	0.0069	0.0358	-0.0426
VW0 (d)	-0.6326*** (0.1589)	-0.0116 (0.0515)	-0.2082* (0.0930)	0.0145	0.0684	-0.0829
LTABT0	-0.0180 (0.0228)	-0.0008 (0.0010)	-0.0210 (0.0130)	0.0011	0.0072	-0.0084
LINSP0	0.0282 (0.0164)	-0.0033*** (0.0006)	-0.2339*** (0.0237)	0.0136	0.0795	-0.0931
INSV0	0.0000 (0.0006)	0.0004*** (0.0001)	0.0039*** (0.0005)	-0.0002	-0.0013	0.0015
LATE (d)	0.1132 (0.1135)	-0.0327*** (0.0083)	-0.4339*** (0.0625)	0.0356	0.1350	-0.1707
ABTI (d)	0.3817** (0.1295)	0.0506*** (0.0120)	0.5259*** (0.0685)	-0.0192	-0.1788	0.1980
COMPR (d)	0.1568** (0.0524)	0.0023 (0.0035)	0.2479*** (0.0310)	-0.0144	-0.0840	0.0984
WALK (d)	0.1515** (0.0581)	-0.0060* (0.0028)	0.0471 (0.0332)	-0.0028	-0.0160	0.0187
INTERV (d)	0.4858*** (0.1399)	0.0196 (0.0228)	0.1051 (0.0771)	-0.0056	-0.0360	0.0417
ADVNOTE (d)	0.5379*** (0.1514)	0.0085 (0.0191)	0.0891 (0.0780)	-0.0048	-0.0306	0.0353
RELACC (d)	-0.1066 (0.1119)	-0.0733*** (0.0188)	-0.1835** (0.0601)	0.0125	0.0606	-0.0731
RELCMP (d)	-0.0056 (0.0690)	-0.0029 (0.0035)	-0.0546 (0.0395)	0.0033	0.0184	-0.0218
RELREF (d)	-0.2852* (0.1291)	-0.0183 (0.0112)	0.1767* (0.0704)	-0.0088	-0.0609	0.0697
SAFETY (d)	0.3059*** (0.0472)	0.0010 (0.0024)	0.0732** (0.0266)	-0.0044	-0.0248	0.0291
LWDI	-0.0037* (0.0015)	-0.0009*** (0.0002)	-0.0054*** (0.0008)	0.0003	0.0018	-0.0021
UNION (d)	0.1630* (0.0791)	0.0029 (0.0040)	-0.0894* (0.0443)	0.0049	0.0306	-0.0355
LEMPL	0.1178*** (0.0254)	0.0043** (0.0015)	0.0306* (0.0127)	-0.0018	-0.0104	0.0122
LFEMPL	0.0687 (0.0352)	-0.0047* (0.0024)	-0.0911*** (0.0227)	0.0053	0.0310	-0.0363

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Table 8 – continued from previous page

	RLP OLS	RLP QREG	RPD OPROBIT	RPD P(P1>P0)	RPD P(P1=P0)	RPD P(P1<P0)
ROA	0.0072 (0.0084)	0.0017*** (0.0004)	0.0161*** (0.0047)	-0.0009	-0.0055	0.0064
FNPTS	-0.0024 (0.0057)	-0.0013*** (0.0004)	-0.0131*** (0.0031)	0.0008	0.0044	-0.0052
FSIC (d)	0.2995*** (0.0832)	0.0044 (0.0044)	-0.1953*** (0.0476)	0.0120	0.0657	-0.0777
HCONT	-0.0076*** (0.0021)	-0.0004** (0.0001)	-0.0042*** (0.0012)	0.0002	0.0014	-0.0017
HRPEN	0.0005 (0.0012)	-0.0001* (0.0001)	-0.0024*** (0.0007)	0.0001	0.0008	-0.0010
HVIO	-0.0158* (0.0065)	-0.0053*** (0.0012)	-0.0166*** (0.0039)	0.0009	0.0057	-0.0066
HNINSP	0.0024 (0.0014)	-0.0003*** (0.0001)	-0.0019* (0.0008)	0.0001	0.0007	-0.0008
FHCONT	0.0010 (0.0018)	0.0005*** (0.0001)	0.0017 (0.0011)	-0.0001	-0.0006	0.0007
FHRPEN	0.0009 (0.0013)	-0.0001** (0.0001)	-0.0024*** (0.0007)	0.0001	0.0008	-0.0010
FHVIO	-0.0100* (0.0047)	0.0004 (0.0003)	-0.0058* (0.0028)	0.0003	0.0020	-0.0023
FHNINSP	-0.0056** (0.0020)	-0.0008*** (0.0002)	-0.0036** (0.0011)	0.0002	0.0012	-0.0014
RHCONT	-0.0040 (0.0024)	0.0003* (0.0001)	0.0033* (0.0014)	-0.0002	-0.0011	0.0013
RHRPEN	-0.0062** (0.0019)	-0.0004*** (0.0001)	0.0012 (0.0011)	-0.0001	-0.0004	0.0005
RHVIO	0.0100 (0.0131)	0.0013 (0.0008)	0.0053 (0.0075)	-0.0003	-0.0018	0.0021
RHNINSP	-0.0003 (0.0002)	-0.0001*** (0.0000)	-0.0005*** (0.0001)	0.0000	0.0002	-0.0002
NE (d)	-0.5313*** (0.0608)	-0.0222*** (0.0056)	0.0569 (0.0324)	-0.0033	-0.0194	0.0226
SO (d)	-0.0402 (0.0854)	0.0022* (0.0015)	0.0749 (0.0473)	-0.0042	-0.0256	0.0298
S (d)	0.1215 (0.0884)	-0.0017 (0.0037)	-0.0676 (0.0436)	0.0041	0.0228	-0.0269
O (d)	0.1495 (0.0875)	-0.0232*** (0.0057)	-0.0963* (0.0471)	0.0060	0.0324	-0.0384
CONST	1.0334* (0.4929)	0.0027 (0.0150)				
CUT1			0.2814 (0.1612)			
CUT2			2.1804*** (0.1620)			
LL	-26952.288		-8378.014			
R2	0.214	0.335	0.206			
N	12190	12190	12190			

Source: OSHA IMIS, 1990-2000

Significance: \* – 0.1, \*\* – 0.05, \*\*\* – 0.01. Standard errors are adjusted for clustering of the residuals at the inspection level.

Table 9: Extension of the Abatement Deadline

	ETABTD HECKPROB	ETABTD P(ETABT>0)	LETABT TOBIT	LETABT P(ELTABT>0)	LETABT E(ELTABT  > 0)	LETABT E(ELTABT)
PIS	0.0037** (0.0013)	0.0006	0.0516*** (0.0156)	0.0086	0.0015	0.0049
PFS	-0.0058* (0.0028)	-0.0008	-0.0012 (0.0185)	-0.0002	-0.0000	-0.0001
PTR	-0.0071* (0.0033)	-0.0011	-0.0285 (0.0205)	-0.0047	-0.0008	-0.0027
LP0	-0.0403*** (0.0110)	-0.0060	-0.1838** (0.0631)	-0.0306	-0.0053	-0.0174
VS0 (d)	0.4449*** (0.0778)	0.0668	2.4534*** (0.4780)	0.3935	0.0645	0.2093
VR0 (d)	0.4610*** (0.1248)	0.1032	2.9094*** (0.7066)	0.5529	0.1093	0.4104
VW0 (d)	0.1660 (0.1588)	0.0289	1.2626 (0.8580)	0.2216	0.0407	0.1414
LTABT0	0.1898*** (0.0192)	0.0281	1.1862*** (3.2207)	0.1973	0.0340	0.1126
LINSP0	0.1751*** (0.0384)	0.0283	0.3343*** (0.0938)	0.0556	0.0096	0.0317
INSV0	-0.0071*** (0.0011)	-0.0012	-0.0317*** (0.0044)	-0.0053	-0.0009	-0.0030
LATE (d)	-0.0069 (0.0977)	-0.0031	-0.4620 (0.5863)	-0.0755	-0.0127	-0.0415
COMPR (d)	-0.1322** (0.0449)	-0.0213	-0.5105* (0.2493)	-0.0849	-0.0146	-0.0485
WALK (d)	-0.1562*** (0.0469)	-0.0281	-0.6835* (0.2705)	-0.1150	-0.0201	-0.0673
INTERV (d)	0.3295** (0.1078)	0.0688	3.1914*** (0.6278)	0.6092	0.1207	0.4561
ADVNOTE (d)	0.1900 (0.1360)	0.0488	2.1972** (0.7752)	0.4054	0.0782	0.2849
RELACC (d)	0.0144 (0.0880)	0.0024	-0.9051 (0.5367)	-0.1451	-0.0238	-0.0765
RELCMP (d)	0.2263*** (0.0572)	0.0424	0.9954** (0.3170)	0.1717	0.0309	0.1059
RELREF (d)	0.0375 (0.0948)	0.0059	0.3807 (0.5646)	0.0644	0.0113	0.0381
SAFETY (d)	-0.0410 (0.0382)	-0.0088	-0.0535 (0.2185)	-0.0089	-0.0015	-0.0051
LWDI	0.0003 (0.0010)	0.0001	-0.0038 (0.0062)	-0.0006	-0.0001	-0.0004
UNION (d)	0.1835** (0.0646)	0.0283	0.8504* (0.3737)	0.1374	0.0227	0.0736
LEMPL	0.0386* (0.0192)	0.0068	0.2769* (0.1250)	0.0460	0.0079	0.0263
LFEMPL	0.0798* (0.0325)	0.0126	0.3883* (0.1682)	0.0646	0.0111	0.0368
ROA	0.0168* (0.0072)	0.0026	0.1159** (0.0420)	0.0193	0.0033	0.0110

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Table 9 – continued from previous page

	ETABTD HECKPROB	ETABTD P(ETABT>0)	LETABT TOBIT	LETABT P(ELTABT>0)	LETABT E(ELTABT  > 0)	LETABT E(ELTABT)
FNPTS	-0.0005 (0.0044)	-0.0001	0.0067 (0.0265)	0.0011	0.0002	0.0006
FSIC (d)	-0.3058*** (0.0629)	-0.0444	-1.3848*** (0.3615)	-0.2261	-0.0380	-0.1243
HCONT	0.0019 (0.0017)	0.0003	0.0114 (0.0098)	0.0019	0.0003	0.0011
HRPEN	-0.0063*** (0.0012)	-0.0009	-0.0381*** (0.0072)	-0.0063	-0.0011	-0.0036
HVIO	0.0023 (0.0050)	0.0003	0.0130 (0.0289)	0.0022	0.0004	0.0012
HNINSP	0.0013 (0.0012)	0.0002	0.0083 (0.0072)	0.0014	0.0002	0.0008
FHCONT	0.0063*** (0.0015)	0.0009	0.0385*** (0.0084)	0.0064	0.0011	0.0036
FHRPEN	-0.0020* (0.0010)	-0.0003	-0.0094 (0.0055)	-0.0016	-0.0003	-0.0009
FHVIO	0.0037 (0.0035)	0.0005	0.0043 (0.0201)	0.0007	0.0001	0.0004
FHNINSP	-0.0003 (0.0018)	-0.0001	-0.0064 (0.0102)	-0.0011	-0.0002	-0.0006
RHCONT	-0.0009 (0.0021)	-0.0001	-0.0069 (0.0121)	-0.0012	-0.0002	-0.0007
RHRPEN	-0.0053*** (0.0015)	-0.0008	-0.0314*** (0.0083)	-0.0052	-0.0009	-0.0030
RHVIO	0.0090 (0.0108)	0.0013	0.0489 (0.0618)	0.0081	0.0014	0.0046
RHNINSP	-0.0004* (0.0002)	-0.0001	-0.0028** (0.0010)	-0.0005	-0.0001	-0.0003
NE (d)	-0.1273** (0.0458)	-0.0228	-0.4248 (0.2792)	-0.0703	-0.0120	-0.0397
SO (d)	-0.3909*** (0.0706)	-0.0549	-1.8301*** (0.4136)	-0.2912	-0.0472	-0.1516
S (d)	-0.2968*** (0.0666)	-0.0397	-1.3715** (0.4414)	-0.2201	-0.0361	-0.1165
O (d)	0.3458*** (0.0729)	0.0739	2.5657*** (0.3995)	0.4654	0.0883	0.3177
CONST	-1.9511*** (0.2388)		-20.9354*** (2.5503)			
ATHRHO	0.6615* (0.3660)					
SIGMA			5.8971*** (0.1402)			
LL	-6987.127		-6544.833			
R2			0.092			
N	12190		10865			

Source: OSHA IMIS, 1990-2000

Significance: \* – 0.1, \*\* – 0.05, \*\*\* – 0.01. Standard errors are adjusted for clustering of the residuals at the inspection level.

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